STUDIES ON SPHAEROTHECA FULIGINEA INFECTING CUCURBITS

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Dated, January 10, 1975.

This is to certify that Mr. Mohd. Akram has worked in this Department as a Research Scholar under my supervision and guidance. His work on the "Studies on Sphaerotheca fuliginea (Schlecht) Poll. infecting cucurbits" is upto-date and original. He is allowed to submit his thesis for the consideration of the award of the degree of Doctor of Philosophy.

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C O N T E N T S

I. INTRODUCTION AND REVIEW OF LITERATURE

ORIGIN OF CUCURBITS

The family Cucurbitaceae contains about ninety genera and 750 species, almost equally divided between the new and old world tropics. According to Chakarvarty (1959), out of the 108 species occurring in India, 38 are apparently endemic. Of these, some are confined to peninsular India and Ceylon and others to the Eastern Himalaya and Burma. Rheede (1805) and Roxburgh (1832) reported that Lagenaria vulgaris had been found to be wild in India. De Candolle (1882) reported that Citrullus vulgaris was indigenous to tropical Africa, while Mangalo (1930, 1944, 1955) on the basis of extensive studies on asiatic watermelons concluded that C. vulgaris was indigenous to India. Naudin (1859) pointed out that species of Cucumis were African in origin except C. sativus and suggested that it could had been introduced into the America through slave-trade. Hooker (1879) expressed the same views. According to Heeuse (1958) Cucumis sativus was a cultigen descended from a non-bitter variant (mutant) of an African wild species, described as Cucumis longipes Hook., which normally had bitter fruits. There are undoubtedly well developed secondary centres of origin of

C. melo in India, Persia, Southern Russia, and China.

According to Naudin (1859) Luffa cylindrica was probably a native of Southern Asia, and perhaps also of Africa, Australia and Polynesia. Wheeler (1905) observed L. cylindrica growing in sandy places, in woods and other localities in Malabar, while Roxburgh (1832) claimed that "it was wild in undivided Indian subcontinent; Kurz in the forests of Burma and Thwaites, in Ceylon". Clarke (1879) claimed that L. acutangula was indigenous to British India. Bailey (1929), while discussing the origin of the domesticated species of Cucurbita presented convincing evidence that it had Mexican or Texan origin. According to Erwin (1931) there was a good evidence that Cucurbita moschata and C. pepo were indigenous to South America. About Trichosanthes cucumina Bretschneider (1881) proposed that the Chinese name Tankua, means, "Cucumber of the Southern barbarians". Regarding L. aegyptiaca, Clarke (1879) pointed out that its original home had been India.

Importance of Cucurbits

Cultivated cucurbits are of great economic importance. Many of edible ones are used as food or as ingradients of salads. Their significance as a food crop lies because still bulk of the population in this country happens to be vegetarian. Moreover, they are excellent source of vitamins

and minerals, from seeds of certain cucurbits, oil is extracted. From the hollow dried fruits of Lagenaria leucantha are made "sitars", an old musical instrument. Benincasa hispida is primarily used in confectionary industry, however, it along with a few species of Citrullus vulgaris and of Cucumis have medicinal importance.

Cultivation of Cucurbits in India

Cucumbers, melons, pumpkins, squashes and gourds are hot-weather crops and are mostly trailers with the exception of bush varieties of squash. They thrive best in light loamy soils and are grown all over India. Pointed gourd and small gourd are seldom grown in north-west India and the Indian squash melon, water-melon and muskmelon in the hills. All of them are propagated from the seeds, however, pointed gourd and small gourd can also be propagated by cuttings.

In the hilly regions, the seed is sown from April to July while in the plains from January to March. Late rainy season crops of bitter gourd and Indian squash melon are also raised during May to July.

In India the average yield per acre for muskmelon ranges 8,000 lb. to 10,000 lb., long melon 12,000 lb., cucumber 7,000 lb. to 8,000 lb., watermelon 6,000 lb. to 8,000 lb., bittergourd 5,000 lb. to 8,000 lb., pointed

gourd 8,000 lb. to 10,000 lb., small gourd 15,000 lb. to 20,000 lb., pumpkin 16,000 lb. to 24,000 lb. and vegetable marrow 8,000 lb. to 10,000 lb. This yield data is far below than obtained in the U.S.A. (Anonymous, 1969).

[illegible] Powdery Mildews of Cucurbits and Losses

Cucurbits are attacked by large number of plant pathogens (Whitaker and Davis, 1962). In amongst them the most serious is the powdery mildew fungus. Szembel (1930) and McKeen (1951) reported that it reduced cucumber yields by 75% and 50% respectively in the U.S.A. Heavy losses have also been reported from Bulgaria by Tafradzhiiski (1959). Since bulk of the population is vegetarian in India and therefore, cucurbits are of great economic importance as a source of food and a little work has been carried out on powdery mildew of cucurbits.

The family Erysiphaceae contains many serious plant pathogens commonly known as 'Powdery mildews'. The disease earned its name because of the enormous number of conidia produced on the surface of the host. The fungus attacks the stems and young leaves, the latter becomes chlorotic and may be killed. Fruits on infected plants ripen prematurely and lack the netting, texture, flavour and sugar contents of marketable fruits. Sometimes fruits too do not

set or remain smaller in size.

IDENTIFICATION OF CUCURBIT POWDERY MILDEWS

Early Europeans mycologists such as Leveille (1851); Passerini (1867); Fuckel (1869) and Jackzewski (1896) diagnosed the causal organism of powdery mildew of cucurbits as Sphaerotheca castagnei. Humphrey (1892) and Schroeter (1893) in Europe identified it as Erysiphe cichoracearum and E. polygoni respectively. Salmon (1898) for the first time observed the presence of perithecia on Cucurbita pepo plants infected with powdery mildew fungus in which each ascus had two ascospores. This led Salmon to conclude that the causal organism of powdery mildew was E. cichoracearum rather than E. castagnei. Later, he (1900) examined herbarium and exsiccati specimens, which had earlier been described as E. castagnei and observed that specimens lacked perfect stage and in each case the description was based on imperfect stage. This finding convinced him the correctness of his earlier identity and led him to remark, "It is of course possible that more than one species of Erysiphe occurs on these host plants and it would be very interesting to note if any example that perithecia of Sphaerotheca really exists".

Since powdery mildews including cucurbit powdery mildew seldom produce perfect stage in nature, therefore,

criterion other than the perfect stage such as - the color of the mycelium, presence or absence of fibrosin bodies and production of forked germ tube or appressoria like bodies were resorted too for establishing the identity of powdery mildew. On the basis of these characters the powdery mildew of cucurbits was identified as Sphaerotheca fuliginea by Tarr (1952) and Nour (1957) from Sudan; Clare (1958) from South Eastern Queensland, Noble and Ballantyne (1963) from Australia; Boerema and Hankesteren (1964) from The Netherlands; Paracovitis, 1965; Coster, 1966; Blumer, 1967; Kapoor, 1967; Dhooty, 1967; Sivakami et al. 1972; Bineeta Sen and Kapoor, 1974 and S. cichoraceorum by Butler et al. (1954), Mathur et al. (1971) from India; Jagger (1926), Harris (1949), Schmitt (1955) and Ivanoff (1957) from the U.S.A.; Fikry (1936) from Egypt; McKeen (1954) from Ontario, Canada; Blumer (1967).

Neger (1923) reported the perfect stage of S. fuliginea on Epilobium montanum (Onagraceae) and Taraxacum officinale (Compositae) from Germany and Poretzky (1923) from Tiflis; Deckenbach (1924) from the South Coast of Crimea and Izembel (1926) from Astrakhan on melon leaves; Blumer (1933) on Adenostyles alliariae and Arnica montana (Compositae), Arabis alpina (Cruciferae), Bidens carnuus, B. melanocarpus, B. tripartitus, Bellidiastrum michelii, Calendula officinalis,

Crepis paludosa, C. blattarioides (Compositae), Capsella bursa-pastoris (Cruciferae), Cucurbita sp. (Cucurbitaceae), Erigeron acer and E. canadensis (Compositae), Euphrasia brevirila, E. minima, E. odontites, E. rostkoviana, E. salisburgensis and E. stricta (Scrophulariaceae), Helianthemum canum, H. grandiflorum, H. nitidum and H. vulgare, Leontodon hispidus and L. hastilis (Compositae), Melampyrum arvense, M. cristatum, M. nemorosum, M. pratense, M. silvaticum and Pedicularis japonica (Scrophulariaceae), Physalis alkekengi (Solanaceae), Plantago lanceolata and P. media (Plantaginaceae), Pulicaria dysenterica and Taraxacum officinale (Compositae), Trollius europaeus (Ranunculaceae), Veronica arvensis, V. barrellieri, V. candida, V. grandis, V. helerifolia, V. incana, V. kerneri, V. urticifolia, V. maritima, V. orchidacea, V. pseudochamaedrys, V. spicata and V. spuria (Scrophulariaceae) Reese (1939) from Pennsylvania on various wild hosts; Baker (1943) from California on Delphinium amabile (Ranunculaceae); Moore (1947) from England on Doronicum species (Compositae); Kozumi and Yosii (1952) from Japan on various cucurbits; Parr (1957) from Sudan on Acalypha indica (Euphorbiaceae); Raabe (1964) from California on Heuchera sanguinea (Saxifragaceae), from Aberdeen Garden on Veronica longifolia var. subsessilis (Scrophulariaceae); Patil (1964), Patwardhan (1965) from Maharashtra and Prasad et al. (1968) from Rajasthan

(India) reported the perfect stage of S. fuliginea on Helianthus annuus; Mathur et al. (1971) from Durgapura, Jaipur on Dimorphotheca sinuata (Compositae).

HOST RANGE

Large number of cultivated and wild species have been recorded as the hosts of the members of Erysiphaceae. Salmon (1900) in his 'Monograph of the Erysiphaceae' listed about 1500 hosts species, as the hosts of powdery mildews. Blumer (1967) recorded powdery mildews on 1928 plant species of angiosperms. Weiss (1950) found powdery mildews on 1340 out of 3100 host species given in U.S.D.A. index of plant diseases.

S. fuliginea is considered to be serious pathogen of cucurbits and certain non-cucurbits. Salmon (loc. cit. reported that S. fuliginea attacked 103 species belonging to 55 genera and 18 different families. The list did not include any member of the family Cucurbitaceae.

Blumer (1967) listed 110 species belonging to 42 genera and 16 families as the hosts of S. fuliginea including Cucumis melo, C. sativus, C. ficifolia, Cucurbita maxima, C. pepo and C. verrucosa in the family Cucurbitaceae.

Foex (1924) reported S. fuliginea on Erodium malacoides (Geraniaceae); Buchwald (1936) on Veronica andersonii and V. myrtifolia (Scrophulariaceae); Rud (1938), Moore (1952), Williamson (1953), Eliade (1960), Akhundov et al. (1963), Anonymous (1964) on Calendula officinalis (Compositae); Tai (1936) on Phaseolus vulgaris, P. mungo and Cowpea (Leguminosae); Ikata (1951) on P. angularis; Viennot-Bourgin (1969) on Phaseolus species; Cheremisinov (1951) on Taraxacum kok-saghyz (Compositae); Tarr (1954) on Sesamum indicum (Pedaliaceae); Hagen (1952) on Pedicularis labradorica (Scrophulariaceae); Dingley and Brien (1956) on Coriaria angustissima and C. thymifolia (Coriariaceae); Morochkovskii (1958) on Scabiosa ochroleuca (Dipsacaceae); Vasudeva (1957-58) on Cosmos species (Compositae); Devarennes et al. (1964) and Jhooty (1965) on Zinnia species; Kowalski (1966) reported on Adonis vernalis (Ranunculaceae); Movsesyan (1967) observed S. fuliginea f. Dahliae on Dahlia variabilis (Compositae); Alcorn (1968), Munjal and Kapoor (1973) included Carica papaya (Caricaceae) in this host list.

Vasudeva (1960) included 7 plant species as the hosts of S. fuliginea viz., Bidens pilosa, Siegesbeckia orientalis, Taraxacum officinale (Compositae); Cucurbita maxima, C. moschata and Lagenaria leucantha (Cucurbitaceae); Phaseolus vulgaris (Leguminosae). Tilak and Ramchandra Rao (1967) added

5 hosts of this fungus namely Parthenium hysterophorus, Helianthusannuus, and Senecio grahimis (Compositae); Impatiens balsamina (Balsaminaceae); Potentilla sriocarpa (Rosaceae). Sarbhoy et al. (1974) included Striga densiflora, S. lutea (Scrophulariaceae) and Dimorphotheca sanuali (Compositae) in this host list.

Butler (1918), Sohi and Nayar (1969), Kapoor (1967) reported that S. fuliginea attacked cucurbits in general. Khan and Khan (1970) reported S. fuliginea on Cucumis sativus, Lagenaria leucantha, Luffa acutangula, Melothria maderaspatana and Cucurbita moschata. Khan et al. (1971 and 1972) later concluded that under Indian conditions S. fuliginea attacked mostly cultivated cucurbits. Sivakami et al. (1972) included Cucumis (Cucumber, Muskmelon and long melon), Cucurbita (pumpkin) and Lagenaria (bottle gourd) as the hosts of S. fuliginea.

Salmon (1900) listed 15 species of plants in 12 genera belonging to 5 different families as the common hosts for both E. cichoraceaarum and S. fuliginea, however, he did not include any member of the family Cucurbitaceae in this host list. Muttenbach (1951) from Germany claimed that E. cichoraceaarum and S. fuliginea both occurred on cucurbits. Vasudeva (1960) listed Cucurbita spp. as the common host. Nikiforova (1962) from Bulgaria reported that both these fungi existed together on cucurbits. Blumer (1967) described

Cucumis melo, C. sativus, Cucurbita maxima, C. pepo, C. verrucosa as the common hosts of both the fungi. Rudenko (1968) from Moldavia, U.S.S.R. claimed that E. cichoracearum f. sp. cucurbitacearum attacked all the cucurbits and S. fuliginea f. sp. cucurbitacearum cucumber, marrow, pumpkin, melon and not watermelon. He observed perithecia of both the fungi. Hirata (1966) and Blumer (1967) reported both E. cichoracearum and S. fuliginea on Helianthus annuus.

From this review it is clear that Cucumis melo, C. sativus, Cucurbita maxima, C. pepo and C. verrucosa amongst cucurbits and Abelmoschus esculentus, Adenostyles glabra, Arctium majus, Calendula officinalis, Chrysanthemum carinatum, Cichorium intybus, Crepis paludosa, Gaillardia aristata, Helianthus annuus, H. debilis, Hieracium prenanthoides, Hydrophyllum virginicum, Lapsana communis, Leontodon autumnalis, L. hispidus, Prenathes alba, L. purpurea, Phlox divaricata, Plantago lanceolata, L. media, Taraxacum officinale, Prunella vulgaris, Vernonia noveboracensis, Xanthium canadense, X. italicum, X. spinosum, X. strumarium amongst non-cucurbits are the common hosts for both E. cichoracearum and S. fuliginea.

HOST SPECIALIZATION

Neger (1923) provided the evidence of cross infection with conidia of S. fuliginea from Epilobium montanum on

Taraxacum officinale. Miller (1938) reported glasshouse infection of Carica papaya seedlings with conidia of S. fuliginea in California from cucurbits. Marcelli (1949) observed that in cross-inoculations with conidia of S. fuliginea from Cucurbita maxima onto squash, Cucumis anguria, C. melo, Citrullus vulgaris and tobacco varieties resulted in the development of the mildew except on tobacco varieties.

Huttenbach (1951) reported that conidia from potato on cucumber and vice versa resulted in infection. According to Uozumi and Yoshii (1952) S. fuliginea from Bidens bipinnata was not pathogenic to cucumber but from Arctium lappa was. S. fuliginea, on the other hand, from cucumber was pathogenic on A. lappa and Phaseolus radiatus but not on Solanum melongena, Chrysanthemum coronarium, Helianthus tuberosus, H. annuus and Nicotiana tabacum. Nour (1959) observed that conidia of S. fuliginea obtained from the field from Cucurbita pepo or from Cucumis sativus were able to cause infection on Hibiscus esculentus. Similarly, cross inoculations from H. esculentus onto C. pepo or C. sativus were all successful. Nowalski (1966) successfully inoculated S. fuliginea from Adonis vernalis to A. vernalis and Calendula officinalis but not to Trollius europaeus. Alcorn (1968, 1969) claimed that cucumber isolate of S. fuliginea was able to infect certain

plant species outside the family Cucurbitaceae viz., Cyamopsis tetragonoloba, Dolichus uniflorus, Phaseolus lathyroides, P. vulgaris, Vigna vexillata, H. esculentus, Verbena hybrida, Carica papaya, Glycine javanica, H. trionum, Physalis sp., Verbena bonariensis and Vigna lanceolata, and that conidia from the above hosts infected cucumber. Munjal and Kapoor (1973) also successfully inoculated S. fuliginea from C. pepo to Carica papaya and vice versa.

ENVIRONMENT AND POWDERY MILDEWS

Infection in powdery mildews, by and large, is initiated by conidia and rarely by ascospores (Salmon, 1903; Steiner, 1908; Blodgett, 1913; Hammarlund, 1925; Cherewick, 1944; Delmas, 1953; Power and Moseman, 1956; Schnathorst, 1959) or overwintering mycelium present in the dormant buds (Smith, 1894; Neger, 1915; Yossifovitch, 1923; Woodward, 1927; Peterson and Johnson, 1928, 1944, 1955; Yarwood, 1939; Dillon Weston et al. 1943; Yarwood, 1944, 1957; Weinhold, 1961). Consequently much of the work on biology of powdery mildews has been carried out on the conidial stage.

Out of the various environmental factors temperature, moisture, (Delp, 1954; Yarwood, 1957 and Schnathorst, 1965) and soil fertility (Yarwood, 1959) appear to have a profound

effect on the development of powdery mildew.

Hashioka (1937) studied the cardinal temperatures for the germination of conidia of cucumber strain of E. fuliginea and observed that 15°, 22°-31° and 34°C were the minimal, optimal and maximal temperature respectively. Tafradzhiiski (1963) on the other hand, found 15°-20°C as the optimal and 30°-35°C as the maximal.

Hashioka (1937) observed that the incubation period was 4, 3 and 7 days at 19.5° to 20.5°C, 24° to 28°C and 32°C respectively. He further claimed that optimum temperature for infection of cucurbits was 28°C.

Yarwood (1965) reported that pinto bean and black eye cowpea normally resistant to E. fuliginea, became susceptible when subjected to heat-therapy for 5-64 sec. for 20 sec. at 50°C and 1-8 sec. (Optimum) at 55°C.

Bioletti (1907) reported that low temperature favoured the development of perithecia. The role of temperature on perithecial development of E. graminis was studied by Cherewick (1944) and Arya and Ghemawat (1953). They observed that alternate low and moderate temperatures during the growth of the plant favoured the development and maturation of perithecia of E. graminis.

Moisture greatly influences the germination of conidia, the infection and the development of powdery mildews.

Hashioka (1937) found that conidia of S. fuliginea germinated between relative humidity 15-85% and that conidia survived for 14 days at 76% to 80% relative humidity, 24 days at 93 to 98% and for 38 days in a saturated atmosphere. Tafradzhiiski (1963) reported that conidia of S. fuliginea germinated best at relative humidity 94% but they failed to germinate in drops of water.

Schnathorst (1965) critically reviewed this aspect and pointed out that in place of relative humidity moisture stress as determined by vapour pressure deficit (VPD) was more indicative of the response observed in germinating mildew conidia. VPD can be calculated by the formula:

$$VPD = (1-RH)\ E$$

where E is the vapour pressure at saturation at a given temperature, and RH the relative humidity. The vapour pressure deficit changes if temperature changes, even when the relative humidity remains constant.

On the basis of VPD, Schnathorst (1965) divided the powdery mildews into three categories, based on their response to moisture stresses.

Hashioka (1937) reported that more infection occurred at 96% RH than at 97 or 100% and at 69% as against 55°C. Massee, 1903; Blodgett, 1913, 1915; Brisley, 1926; Beeley, 1932;

Moore, 1936; Fisher, 1938; Bremer, 1940; Farris, 1949; on the other hand, reported favourable effect of rain, dew (Easthem and Ruhman, 1924; Fisher, 1938; Ubrizsy, 1946); Fogy weather (Carter, 1915; Ballard et al. 1914) and sprinkling water (Reeves and Blodgett, 1949; Sprague, 1955), on powdery mildews.

Buchheim (1928) and Blumer (1948) reported that the formation of perithecia occurred only under low moisture conditions. Schnathorst (1959) reported the formation of functional perithecia at 13°C, 60% relative humidity and 900 ft. candles illumination and in saturated atmospheric conditions at 23°C with 300 ft. candles illumination. Salmon (1903), Yossifovitch (1923) and Moseman et al. (1957) reported that free water was essential for the maturation of ascospores.

Soil fertility:

Severity of mildew is positively correlated with plant vigour and that any soil or other factor which promote plant vigour also favours the development of powdery mildew (Arnaud and Arnaud, 1931; Smith and Blair, 1950).

Spinks (1913), Schaffnit et al. (1930), Trelease and Trelease (1928) and Mansson (1955) found that low nitrogen and high potassium had reduced the development of powdery mildew. Cole (1964, 1966), on the other hand, reported plants

grown in water-culture fortified with all the elements were more susceptible to Erysiphe cichoracearum than those grown in which the ratio of potassium and nitrogen was low.

Soil fertility and perithecial production:

Laibach (1930) and Homma (1937) reported that low nutritive condition of host favoured the development of perithecia. The formation of ascospores of E. graminis according to Arya and Chemawat (1953) was fascilitated by submerging abortive perithecia in dilute nitric acid, sucrose and potassium nitrate.

MATERIALS AND METHODS

During the course of the preliminary survey of cucurbit growing areas in north India, severe infection of powdery mildew fungus was observed on Melothria madraspatana and Luffa cylindrica at Aligarh, (U.P.) on L. leucantha and Cucurbita moschata at Sanatnagar (Kashmir) and on C.moschata at Ranikhet. The infected leaves of the above plants were brought to Aligarh in polythene bags, for future studies.

Seedlings of L. leucantha and L. cylindrica were inoculated with the conidia obtained from the abortive cultures. L. leucantha and C. moschata from Kashmir and C. moschata from Ranikhet. Infection developed within 3-5 days. The culture of powdery mildew obtained from M. madaraspatana, L. cylindrica of Aligarh, cultures obtained from different hosts and from L. leucantha, C. moschata of Kashmir and C. moschata of Ranikhet have been arbitrarily named in the present studies as Ll_1, Lc_1, Ll_2, Cm_1 and Cm_2 respectively. They were maintained in separate glasshouse chambers and were used as such throughout the studies. Besides the above heavy to moderate infection of powdery mildew was also observed on Abelmoschus esculentus, Solanum melongena, Helianthus annuus, Zinnia elegans and Xanthium strumarium at Aligarh. Their cultures were also raised by inoculating the respective hosts and were used for further studies.

Inoculation technique

Seeds of different plants were surface sterilized and later planted in autoclaved soil. Seedlings in the cotyledons or 3-4 leaf-stage and at times leaves of mature plants were inoculated. Dry dusting technique as proposed by (Yarwood, 1957) proved to be most successful and, therefore, this technique has been employed throughout the studies.

For host range studies fifteen cultivated cucurbits viz., Benincasa hisrida (Thunb). Cogn., Citrullus vulgaris Schrad., C. vulgaris var. fistulosus Stewart, Cucumis melo Linn., C. melo var. momordica Roxb., C. melo L. var. utilissimus (Duthey and Fuller), C. sativus Linn., Cucurbita maxima Duch. ex. Lam., C. moschata Poiret., C. pepo Linn., Lagenaria leucantha (Duch.) Rusby, Luffa acutangula (Linn.) Roxb., L. cylindrica Linn., Momordica charantia Linn., Trichosanthes anguina Linn.; ten wild cucurbits viz., Bryonopsis laciniosa (Linn.) Naud., Citrullus lanatus (Thunb) Msf., Coccinia cordifolia (Linn.) Cogn., Cucumis anguria Linn., C. melo var. agrestis Naud., Cucurbita ficifolia Bouche, Luffa echinata Roxb., L. graveolans Roxb., Melothria madaraspatana (Linn.) Cogn., and Trichosanthes cucumerina Linn., and thirteen non-cucurbits namely Abelmoschus esculentus Medik.,

Bellis perrennis Linn., Calendula sp., Chenopodium ambrosoides Linn., Chrysanthemum sp., Cosmos sp., Dahlia sp., Helianthus annuus Linn., Plantago rugelii Linn., Sonchus sp., Nicotiana tabacum Linn., Xanthium strumarium Linn., and Zinnia elegans Linn., grown in 23 cm clay-pots containing autoclaved soil were inoculated with five cucurbit isolates of S. fuliginea in glasshouse as well as in the field. The above hosts were also inoculated with the inocula obtained from A. esculentus, C. melongena Linn., H. annuus, X. strumarium and Z. elegans.

Besides cultivated, wild cucurbits and non-cucurbits viz., A. esculentus, Bellis perennis, Calendula sp., Chenopodium ambrosoides, Chrysanthemum sp., Cosmos sp., Dahlia sp., Helianthus annuus, Plantago rugelii, Sonchus sp., Nicotiana tabacum, Xanthium strumarium and Zinnia elegans were also tested as to their reaction to cucurbit isolates of S. fuliginea developed in glasshouse on C. melo, C. sativus, C. vulgaris and C. pepo.

Plants inoculated with different isolates of S. fuliginea were either kept in glasshouse at 8-18°C or were transferred with entire soil to the pits earlier dugged at a distance of 8-12 ft. This was done to avoid injuries to the roots. Healthy seedlings were also transferred. Temperature in field ranged in between 18-22°C at the time tests were made. For each host-parasite combination there were five replicates. Uninoculated plants served as control. Inoculated plants were

transferred to separate glasshouse chambers and regularly examined for the appearance of the disease. Observations were made on the twenteith day after inoculation. Host response has been categorised as under:-

Resistant (R) = Mildew failed to appear.
Susceptible (S) = Mildew appears.

For studying the varietal resistance different cultivars of B. hispida var. Khola petha$_1$ (Cooper seeds), petha gourd$_1$ (Pocha seeds), petha gourd$_2$ (Prakash seeds), petha gourd$_3$ (Punjab seeds) and ash gourd$_1$ (Bharat beej); C. vulgaris varieties red seeded$_1$ (American seeds), Jaunpuri$_1$ (Namdeo seeds), Allahabadi$_1$ (Munnar seeds), Bareilly kalan$_1$ (Namdeo seeds), black seeded$_1$ (Salma seeds), sugar sweet$_1$ (Cooper seeds), Faizabadi$_1$ (Naik seeds), Faizabadi$_2$ (American seeds, Farrukhabad$_1$ (Cooper seeds), Farrukhabadi$_2$ (Sheela seeds), watermelon$_1$, hard skin$_1$ (Salma seeds), water melon$_2$, white seeded$_1$ (Punjab seeds), Indian green$_1$ (Namdeo seeds), Jaunpuri$_2$ (Naik seeds), mixed$_1$, midget$_1$ (Cooper seeds), quatar-gola$_1$, white seeded$_2$ (Bharat beej), red seeded$_2$ (Salma seeds), watermelon$_3$ (Prakash seeds), tarmuj$_1$ (Sutton seeds), Soft skin$_1$ (Cooper seeds), and white seeded$_3$

(Salma seeds); varieties of C. vulgaris var. fistulosus viz. dilpasand tinda$_1$ (Sutton seeds), dilpasand tinda$_2$ (Pocha seeds), Lucknow special$_1$ (Cooper seeds), tinda Delhi$_1$ (Munnar seeds) and gourd tinda$_1$ (Sutton seeds); varieties of C. melo viz. delicious$_1$ (Namdeo seeds); Faizabadi$_1$, honey sugar-rock$_1$ (Nasik seeds), Jaunpuri$_1$ (Jaunpur), Kharra$_1$, Lucknow$_1$ (Nasik seeds), Lucknow$_2$ (Sutton seeds), Lucknow$_3$ (Kumaon nursery), Lucknow$_4$ (American seeds), Lucknow$_5$ (Sheela seeds), Lucknow sweet$_1$ (Pocha seeds), Muskmelon$_1$, muskmelon$_2$, muskmelon$_3$, muskmelon$_4$, muskmelon$_5$, (American, Punjab, Globe, Kisan and Nasik seeds), Roys$_1$ (Globe nursery), solid rock$_1$ (Cooper seeds), dharidar$_1$, Jaunpuri$_2$ (Bharat beej), Faizabadi$_2$, Kharra$_2$ (American seeds), honey sugar rock$_2$ (Cooper seeds), Plain sweet$_1$ (Bharat beej), Faizabadi$_3$, mixed$_1$, model$_1$ (Cooper seeds), muskmelon$_6$ (Sutton seeds); delicious$_{51}$, spartan rock, Edisto$_{47}$, Campo, Hales Best No. 36, Jacumba, PMR$_6$, PMR$_{45}$ (U.S.A.), local collections of C. melo namely local$_1$ to local$_{30}$; varieties of C. melo var. momordica viz. Large$_1$, long$_1$, small$_1$ (Ghazipur), Phoont$_1$ (American seeds); varieties of C. melo var. utilissimus viz. hot season$_1$ (Pocha seeds), hirvi$_1$ (Nasik seeds), Jaunpuri$_1$ (Jaunpur), kakri$_1$ (Kisan seeds), Lucknow$_1$ (Globe nursery), Lucknow geteer$_1$ (Radhey seeds), White long Faizabadi$_1$ (American seeds), Kakri$_2$ (Salma seeds), Lucknow$_2$

(Radhey seeds), melon kakri$_1$ (Sutton seeds), hot season$_2$ (Radhey seeds), kakri$_3$ (Punjab seeds), Lucknow$_3$ (Munnar seeds), melon kankaur$_1$ (Sutton seeds), phoont$_1$, white long Lucknow$_1$ (American seeds); C. sativus varieties, all season$_1$ (Cooper seeds), early$_1$ (Prakash seeds), hot season$_1$, improved long green$_1$ (Cooper seeds), Indian$_1$ (Sutton seeds), kheera$_1$, kheera$_2$, kheera$_3$, kheera$_4$, (Bulandshahr), Durbhanga, Globe, Prakash seeds), long$_1$, long$_2$ (Jagadhri, Nasik seeds), long green$_1$ (Pocha seeds), long summer$_1$ (American seeds), Lucknowi$_1$, rainy season$_1$ (Cooper seeds), Poona kheera$_1$, Lucknowi$_1$ (Pocha seeds), bhunya$_1$, kashmiri long$_1$ (Globe nursery), short green$_1$ (Sutton seeds; C. maxima$_1$ (Central Europe); C. pepo$_1$(Sheela seeds); varieties of C. moschata viz. early white bush$_1$, English marrow$_1$, vegetable marrow$_1$, (Copper seeds), bright red$_1$, red large$_1$, white bush$_1$, (Globe nursery); varieties of L. leucantha viz. dhoodhi long$_1$, doodhi long summer$_1$, doodhi round$_1$, lauki Singapuri$_1$ (Cooper seeds), bottle gourd$_1$, long white$_1$, (Pocha seeds), lauki long$_1$, ribbed long green$_1$, long thin variety$_1$ (Salma seeds), lauki long$_2$ (Prakash seeds), lauki round$_1$ (Sutton seeds); L. acutangula varieties black seeded$_1$ (Cooper seeds), jhinga turai$_1$ (Sutton seeds), jhinga baropata$_1$, jhinga bhunya$_1$ (Globe nursery); varieties of L. cylindrica viz. all season$_1$, ghia turai$_1$ (Cooper seeds), ghia turai$_2$ (Pocha seeds), small green$_1$, long green$_1$ (Ghazipur); M. charantia varieties viz., all season$_1$ (Cooper seeds),

Faizabadi$_1$ (Munnar seeds), long$_1$ (Kisan seeds), long green$_1$ (Prakash seeds), karela$_1$, karela$_2$ (Sutton, Bulandshahr), rainy season$_1$ (Cooper seeds), summer crop$_1$ (Pocha seeds); varieties of T. anguina viz. all season$_1$ (Cooper seeds), extra long$_1$ (Pocha seeds), extra long special$_1$ (Namdeo seeds), chichinga gourd$_1$ (Sutton seeds), Globe phone$_1$, black$_1$ (Globe nursery), long green$_1$, white$_1$ (Indian seeds), white$_2$ (Globe nursery), snake gourd$_1$, snake gourd$_2$ (Naik seeds, Kumaon nursery), were grown in 23 cm clay-pots were inoculated with different isolates of S. fuliginea from cucurbits and non-cucurbits and were later transferred to glasshouse bench or the field as the case may be.

The above studies were also supplemented by studying the development of powdery mildew on detached leaves or leaf-discs (Morrison, 1961, 1964).

Observation on disease intensity were made daily for two weeks or so after inoculations. Throughout the studies the perithecial production was also examined. Wherever they were produced the time for the appearance of perithecia was also recorded. Later perithecia were dissected and examined to look for asci and ascospores. The following numerical rating for disease intensity have been used throughout (Wheeler, 1969):-

Figure 6

Grade	Description	Infection rating
Highly resistant	Plants completely free from infection.	0
Resistant	Mycelium developing in small patches disappearing later or at best covering 1-25% leaf-area.	1
Moderately resistant	Mycelium developing both on leaves and stem covering 26-50% leaf-area.	2
Susceptible	Many small colonies appearing, later coalesceing and covering 51-75% leaf-area. Mycelium developing on stem as well.	3
Highly susceptible	Entire plant covered uniformly by mildew.	4

Identity of the causal organism on the basis of conidial characters:

Conidia from different cucurbits and non-cucurbits collected from different localities were examined under microscope. 250 conidia were measured from each host. For the presence of fibrosin bodies, conidia were mounted in 3% aqueous KoH as suggested by Kable and Ballentyne (1963). Conidia were then germinated on glass-slides in humid-chamber (Zaracovitis 1965).

Effects of different levels of NPK

For studying the effect of different concentrations of nitrogen, phosphorus and potassium on the disease development and perithecial production of E. fuliginea on L. leucantha varieties ribbed long green and round; C. vulgaris var. sugar sweet (Cooper), the seedlings were raised singly in 25 cm glazed-crocks containing acid leached, washed and moistened yamuna sand. Long Ashton solution (30 ml.), adjusted for different concentrations of nitrogen, phosphorus and potassium (Hewitt, 1966) was added daily (Appendix). There were three replicates for each treatment.

Seedlings grown in the above nutrients were inoculated with conidia of E. fuliginea obtained from L. leucantha. Intensity of the disease was recorded twenty days after inoculation and graded as cited on page 25. Infected plants were also examined for the production of perithecia. Intensity of perithecial production was also noted. Equal number of seedlings were left uninoculated to serve as control.

Effect of different temperatures and relative humidities on the development of E. fuliginea.

For determining the effect of temperature and relative humidity on the development of E. fuliginea, the inoculated seedlings of Cucumis melo variety muskmelon;

C. melo var. utilissimus varieties melon kankur, kakri, Lucknow, hot season, phoont and white long Lucknow and Citrullus vulgaris viz. red seeded, Jaunpuri, Farrukhabadi, mixed, midget, Indian green, tarmuj, watermelon, white seeded and quatar-gola were grown at 15, 20, 26 and 30°C at 70% relative humidity. The effect of 50%, 70% and 95% relative humidities at 20°C was also determined.

The inoculated seedlings were kept in a growth-chamber with 2400 ft. candles light intensity at desired temperature and relative humidity. The disease intensity and the production of perithecia were noted.

For studying the effect of temperature and relative humidity, surface sterilized seeds of four varieties of L. leucantha, viz. ribbed long green, doodhi long summer, doodhi and doodhi long were grown in four inch clay-pots filled with autoclaved soil were inoculated with the conidia of S. fuliginea obtained from original culture maintained in glasshouse. In each case three replicates were used for inoculation purposes.

Inoculated plants were immediately transferred to growth-chamber and kept at different temperatures viz. 5, 10, 15, 17, 20, 22, 25, 30 and 35°C. At each temperature relative humidity maintained was 60, 80, and 90 percent.

At each combination of temperature and relative humidity the plants were regularly watched for the appearance of the disease and perithecia. Disease intensity was recorded after twenty days of inoculation on lower leaves and stem and graded as cited on page A maximum period of one month was provided in each experiment, except in those where the disease failed to appear, to ensure the production of perithecia.

For studying the effect of different relative humidities on conidial germination of S. fuliginea super saturated solutions were prepared as given in the following table (Handbook of Chemistry and Physics, 1957):

Super saturated solutions of	Relative humidities % at 20°C
Sodium nitrate	66
Sodium acetate	76
Ammonium sulphate	81
Zinc sulphate	90
Sodium hydrogen phosphate	95
Double distilled water	100

The solutions were then transferred to the lower chamber of small desiccators which served as humidity chambers. Freshly developed conidia of the same age were

uniformly dusted over the clean cover glasses with the help of a glass-rod (Nair, Sadasivan and Ellingboe, 1962) the entire assembly was kept at 20°C. Germination was studied after 4, 8, 12, 24, 36, 48, 60 and 72 hours of incubation.

For determining the effect of temperature fresh conidia were dusted over the dry clean slides, kept on glass-triangles placed in the petridishes containing double distilled water at the bottom. These were transferred to incubators each running at -5, 5, 10, 15, 20, 25 and 30°C respectively. Germination of conidia at each temperature was studied at different time intervals viz. 4, 8, 12, 24, 36, 48, 60 and 72 hours of incubation.

The conidia that germinated and those which failed to germinate were counted. There were three replicates for each treatment.

Leaves and stem of L. leucantha and C. sativus with perithecia of E. fuliginea were either -

a) kept in small terylene bags and burried in the soil,

b) transferred in plastic tubes stored at -5, 5, 10, 17, 22 , 25 and 30°C for 220 days.

From each treatment plant material having perithecia was fixed to the inner portion of the humidity-chamber, the base of which either had slides on glass-triangle or the floating leaves of cucurbits at the base (Schnathorst, 1959).

The whole assembly was transferred to the temperature cabinets running at seven different temperatures and six combinations of temperatures.

EXPERIMENTAL RESULTS

Identity of the causal organism:

It is clear from Fig. 1 and Table 1 that the colour of the mycelium of M. maderaspatana, L. leucantha, C. moschata, L. cylindrica, A. esculentus, S. melongena, H. annuus, X. strumarium and Z. elegans infected with powdery mildew was greyish-white, the conidia were ellipsoidal to barrel-shaped (Fig. 2), measured 25-37 x 14-25/u, 24.5-28.0 x 14.0-17.5/u, 24.5-31.5 x 14.5-21.5/u, 24.5-31.5 x 14.5-21.5/u, 24.5-31.5 x 14.5-21.5/u, 21.0-28.0 x 10.5-17.5/u, 28.0-35.5 x 10.5-21.0/u, 21.0-28.0 x 10.5-17.5/u, 21.0-31.0 x 10.5-17.5/u and 24.0-35.0 x 14.0-21.0/u respectively. Moreover, conidia had fibrosin bodies (Fig. 3) and on germination the conidia gave rise to the bifurcated germ tube (Figs. 4,5). It is, therefore, concluded that the powdery mildew on the above hosts was Sphaerotheca fuliginea rather than Erysiphe cichoracearum (Table 1).

Host range:-

It is clear from the Table 2 that out of sixteen cultivated cucurbits tested against Ll_1, (M. maderaspatana) and Lc_1 (L. cylindrica) from Aligarh, Cm_1 (C. moschata) from Ranikhet, Ll_2 (L. leucantha) and Cm_2 (C. moschata) from Kashmir isolates of S. fuliginea, Benincasa hispida, Citrullus vulgaris,

TABLE 1

Showing mycelial and conidial characters of powdery mildew from different cucurbits and non-cucurbits.

Localities	Hosts	Color of the mycelium	Presence/ absence of fibrosin bodies.	Measurement of conidia /u	Structur of germ-tub
	CUCURBITS				
Aligarh	Melothria maderaspatana	Gw	FI	25-37 x 14-25	BF
Aligarh	Luffa cylindrica	Gw	FI	24.5-31.5 x 14.5-21.5.	BF
Ranikhet	Cucurbita moschata	Gw	FP	24.5-38.5 x 14.5-21.5	BF
Kashmir	Cucurbita moschata	Gw	FP	21.0-31.5 x 14.0-17.5	BF
Kashmir	Lagenaria leucantha	Gw	FP	24.5-28.0 x 14.0-17.5	BF
	NON-CUCURBITS				
Aligarh	Abelmoschus esculentus	Gw	FP	21.0-28.0 x 10.5-17.5	BF
Aligarh	Solanum melongena	Gw	FP	28.0-45.5 x 10.5-21.0	BF
Aligarh	Helianthus annuus	Gw	FI	21.0-28.0 x 10.5-17.5	BF
Aligarh	Xanthium strumarium	Gw	FP	21.0-31.0 x 10.5-17.5	BF
Aligarh	Zinnia elegans	Gw	FP	24.0-35.0 x 14.0-21.0	BF

Gw = Greyish white
FP = Fibrosin bodies present
BF = Bifurcated germ-tube.

TABLE 2

Reaction of sixteen different cultivated cucurbits against S. fuliginea when inoculated plants are grown in glasshouse or in the field.

Cultivated cucurbits	Reaction against isolates									
	*Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Benincasa hispida	S	S	S	S	S	S	S	S	S	S
Citrullus vulgaris	S	S	S	S	S	S	S	S	S	S
C. vulgaris var. fistulosus	S	S	S	S	S	S	S	S	S	S
Cucurbita maxima	R	R	R	R	R	R	R	R	R	R
C. moschata	S	S	S	S	S	S	S	S	S	S
C. pepo	S	S	S	S	S	S	S	S	S	S
Cucumis melo	S	S	S	S	S	S	S	S	S	S
C. melo var. momordica	S	S	S	S	S	S	S	S	S	S
C. melo var. utilissimus	S	S	S	S	S	S	S	S	S	S
C. sativus	S	S	S	S	S	S	S	S	S	S
Lagenaria leucantha	S	S	S	S	S	S	S	S	S	S
Luffa acutangula	S	S	S	S	S	S	S	S	S	S
L. cylindrica	S	S	S	S	S	S	S	S	S	S
Momordica charantia	S	S	R	R	R	R	R	R	R	R
Trichosanthes anguina	R	R	S	S	S	S	S	S	S	S
T. dioica	R	R	R	R	R	R	R	R	R	R

*Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica

* R = Resistant
S = Susceptible

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

Fig. 1. Leaves and cotyledones of *L. leucantha* infected with powdery mildew.

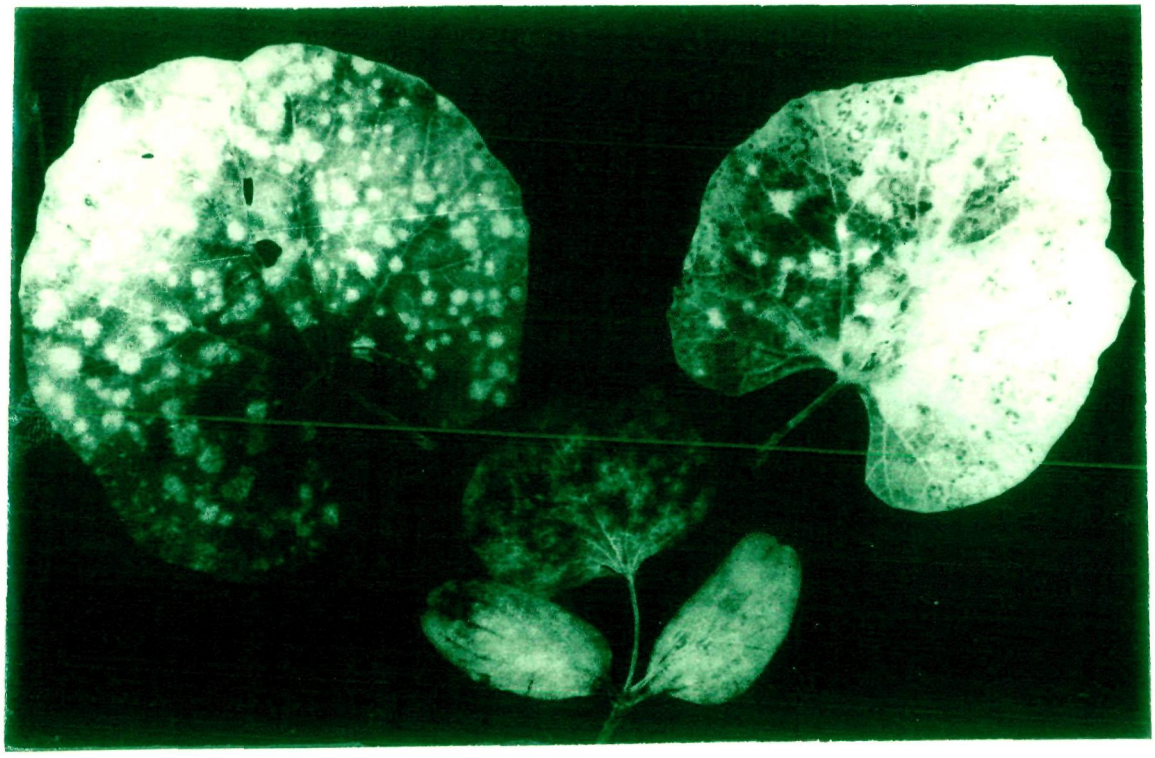

FIG. 1

Dated 21. 4. 75.

Asstt. Registrar (Exams)
A.M.U.Aligarh.

The following thesises are sent

sent herewith:-

1. "Studies on Erysiphe cichoracearum parasitising cucurbitaceous plants"
by Azmatullah Khan.

2. "Response of eggplant seedlings to root-knot nematode, Meloidogyne incognita alone and in combination with Rhizoctonia solani, Pythium sp. and Colletotrichum atramentarium"
by Mohd.Farooq Azam.

3. "Studies on Sphaerotheca fuliginea infecting cucurbits."
by Mohammed Akram.

(Abrar M.Khan)
Professor,
Botany Department
A.M.U. Aligarh.

Fig. 2. Conidia of *Sphaerotheca fuliginea*.

Fig. 3. Conidia of *S. fuliginea* showing fibrosin bodies.

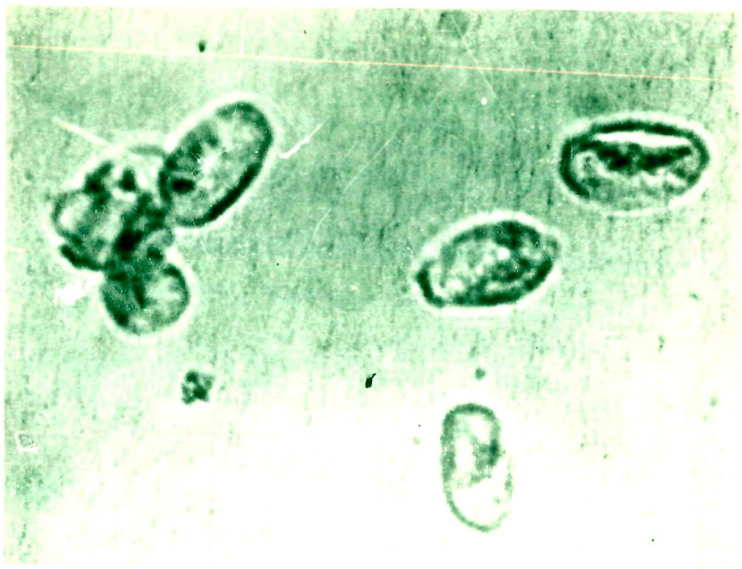

FIG. 2

FIG. 3

Fig. 4. Germinating conidia of *S. fuliginea*

Fig. 5. A germinating conidium of *S. fuliginea* showing bifurcated germ-tube.

FIG. 4

FIG. 5

Fig. 6. Leaves of *L. leucantha* showing disease rating: Highly resistant = 0; Resistant = 1; Moderately resistant = 2; Susceptible = 3; Highly susceptible = 4.

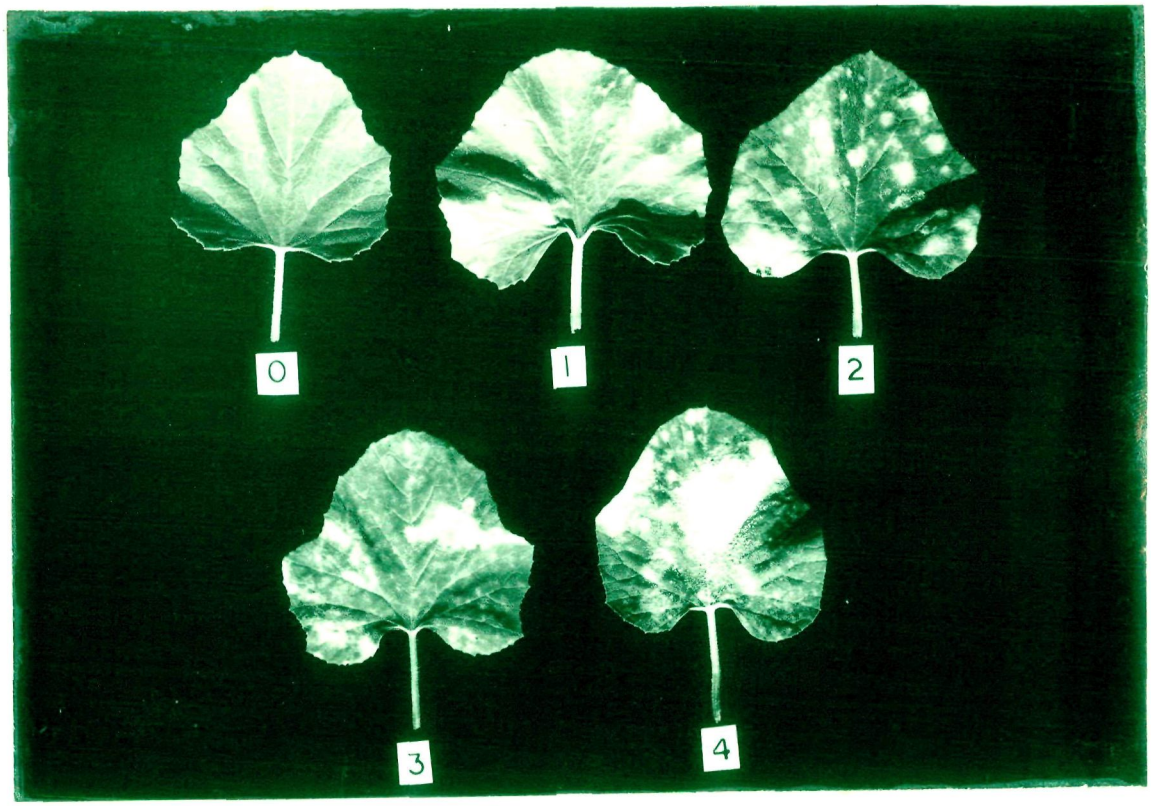

FIG. 6

C. vulgaris var. fistulosus, Cucumis melo, C. melo var. momordica, C. melo var. utilissimus, C. sativus, Cucurbita maxima, (Sutton's) C. moschata, C. pepo, Lagenaria leucantha, Luffa acutangula, L. cylindrica, Momordica charantia and Trichosanthes anguina were susceptible. Only Cucurbita maxima (Central Europe) and T. dioica were resistant. M. charantia and T. anguina were susceptible to Ll_1 isolate and not to Ll_2, Cm_1, Cm_2 and Lc_1 isolates. It is interesting to note that the species of cucurbits which were susceptible in glasshouse also remained susceptible to a varying degree in the field.

Out of ten wild cucurbits tested Melothria maderaspatana, Bryonopsis laciniosa, Cucumis anguria, C. melo var. agrestis, Cucurbita ficifolia and Luffa graveolens were susceptible; whereas Luffa echinata, Citrullus lanatus, Coccinia cordifolia and Trichosanthes cucumerina were resistant against all the cucurbit isolates (Table 3).

Abelmoschus esculentus, Bellis perrennis, Calendula sp., Chenopodium ambrosoides, Chrysanthemum sp., Cosmos sp., Dahlia sp., Helianthus annuus, Physalis sp., Plantago rugelii, Sonchus sp., Nicotiana tabacum, Xanthium strumarium and Zinnia elegans reported as congenial hosts for S. fuliginea (Blumer, 1933; Vasudeva, 1957-58; Patil, 1964; Patwardhan, 1965; Jhooty, 1965; Movsesyan, 1967; Prasada et al. 1968) remained resistant against all the five cucurbit isolates (Table 4).

TABLE 3

Reaction of ten wild cucurbits against S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Plants inoculated	* Reaction against isolates									
	°Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Fie
Melothria maderaspatana	S	S	S	S	S	S	S	S	S	S
Bryonopsis laciniosa	S	S	S	S	S	S	S	S	S	S
Cucumis anguria	S	S	S	S	S	S	S	S	S	S
C. melo var. agrestis	S	S	S	S	S	S	S	S	S	S
Cucurbita ficifolia	S	S	S	S	S	S	S	S	S	S
Luffa echinata	R	R	R	R	R	R	R	R	R	R
L. graveolans	S	S	S	S	S	S	S	S	S	S
Citrullus lanatus	R	R	R	R	R	R	R	R	R	R
Coccinia cordifolia	R	R	R	R	R	R	R	R	R	R
Trichosanthes cucumerina	R	R	R	R	R	R	R	R	R	R

° Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* R = Resistant
S = Susceptible

Temperature range in glasshouse = 8-18½C
Temperature range in field = 18-22°C

TABLE 4

Reaction of thirteen non-cucurbits against *E. fuliginea* when inoculated plants are grown either in glasshouse or in the field.

Plants inoculated	*Reaction against isolates									
	*Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Abelmoschus esculentus	R	R	R	R	R	R	R	R	R	R
Bellis perennis	R	R	R	R	R	R	R	R	R	R
Calendula sp.	R	R	R	R	R	R	R	R	R	R
Chenopodium ambrosoides	R	R	R	R	R	R	R	R	R	R
Chrysanthemum sp.	R	R	R	R	R	R	R	R	R	R
Cosmos sp.	R	R	R	R	R	R	R	R	R	R
Dahlia sp.	R	R	R	R	R	R	R	R	R	R
Helianthus annuus	R	R	R	R	R	R	R	R	R	R
Plantago rugelii	R	R	R	R	R	R	R	R	R	R
Sonchus sp.	R	R	R	R	R	R	R	R	R	R
Nicotiana tabaccum	R	R	R	R	R	R	R	R	R	R
Xanthium strumarium	R	R	R	R	R	R	R	R	R	R
Zinnia elegans	R	R	R	R	R	R	R	R	R	R

R = Resistant
S = Susceptible

°Ll_1 *Melothria maderaspatana* Culture 1.
Ll_2 *Lagenaria leucantha* Culture 2.
Cm_1 *Cucurbita moschata* Culture 1.
Cm_2 *Cucurbita moschata* Culture 2.
Lc_1 *Luffa cylindrica* Culture 1.

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

When cultivated and wild cucurbits and non-cucurbits were inoculated with conidia of S. fuliginea obtained from C. melo, C. sativus, C. vulgaris and C. pepo infected plants, the response of the above hosts was the same as obtained from the original cultures both in glasshouse and in the field (Tables 5, 6, 7).

S. fuliginea cultures from A. esculentus, S. melongena, H. annuus, A. strumarium and Z. elegans failed to cause infection on any of the cultivated and wild cucurbits and non-cucurbits except their respective hosts (Tables 8, 9, 10).

Varietal screening and host-specialization:-

All the five varieties of B. hispida viz. khola petha$_1$, petha gourd$_1$, petha gourd$_2$, petha gourd$_3$ and ash gourd$_1$ were equally susceptible against the five cucurbit isolates of S. fuliginea in glasshouse as well as in field tests as in each case the infection rating was 3 (Table 11).

Out of 25 varieties of C. vulgaris tested red seeded$_1$ and Jaunpuri$_1$ were highly susceptible, Allahabadi$_1$, Bareilly kalan$_1$, Black seeded$_1$, Faizabadi$_1$, Faizabadi$_2$, Farrukhabadi$_1$, Sugar sweet$_1$ and watermelon$_1$ moderately resistant; hard skin$_1$, watermelon$_2$ and white seeded$_1$ resistant and Farrukhabadi$_2$, Indian green$_1$, Jaunpuri$_2$, mixed$_1$, midget$_1$, quatar gola$_1$,

TABLE 5

Reaction of sixteen different cultivated cucurbits against cultures of S. fuliginea obtained from C. melo, C. sativus, C. vulgaris and C. pepo when inoculated plants are grown either in glasshouse or in the field.

Cultivated cucurbits	* Reaction against isolates							
	Cucumis melo		C. sativus		Citrullus vulgaris		Cucurbita pepo	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Benincasa hispida	S	S	S	S	S	S	S	S
Citrullus vulgaris	S	S	S	S	S	S	S	S
C. vulgaris var. fistulosus	S	S	S	S	S	S	S	S
Cucumis melo	S	S	S	S	S	S	S	S
C. melo var. momordica	S	S	S	S	S	S	S	S
C. melo var. utilissimus	S	S	S	S	S	S	S	S
C. sativus	S	S	S	S	S	S	S	S
Cucurbita maxima	R	R	R	R	R	R	R	R
C. moschata	S	S	S	S	S	S	S	S
C. pepo	S	S	S	S	S	S	S	S
Lagenaria leucantha	S	S	S	S	S	S	S	S
Luffa acutangula	S	S	S	S	S	S	S	S
L. cylindrica	S	S	S	S	S	S	S	S
Momordica charantia	R	R	R	R	R	R	R	R
T. dioica	R	R	R	R	R	R	R	R
Trichosanthes anguina	R	R	R	R	R	R	R	R

* R = Resistant
S = Susceptible.

TABLE 6

Reaction of ten wild cucurbits against cultures of *C. fuliginea* obtained from *C. melo*, *C. sativus*, *C. vulgaris* and *C. pepo* when inoculated plants are grown either in glasshouse or in the field.

Wild cucurbits	*Reaction against isolates							
	Cucumis melo		*C. sativus*		*Citrullus vulgaris*		*Cucurbita pepo*	
	Glass	Field	Glass	Field	Glass	Field	Glass	Field
Melothria maderaspatana	S	S	S	S	S	S	S	S
Bryonopsis laciniosa	S	S	S	S	S	S	S	S
Cucumis anguria	S	S	S	S	S	S	S	S
C. melo var. *agrestis*	S	S	S	S	S	S	S	S
Cucurbita ficifolia	S	S	S	S	S	S	S	S
Luffa echinata	R	R	R	R	R	R	R	R
L. graveolans	R	R	R	R	R	R	R	R
Citrullus lanatus	R	R	R	R	R	R	R	R
Coccinia cordifolia	R	R	R	R	R	R	R	R
Trichosanthes cucumerina	R	R	R	R	R	R	R	R

* R = Resistant
  S = Susceptible

TABLE 7

Reaction of thirteen non-cucurbits against cultures of E. fuliginea obtained from C. melo, C. sativus, C. vulgaris and C. pepo when inoculated plants are grown either in glasshouse or in the field.

Non-cucurbits	*Reaction against isolates							
	Cucumis melo		C. sativus		Citrullus vulgaris		Cucurbita pepo	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Abelmoschus esculentus	R	R	R	R	R	R	R	R
Bellis perennis	R	R	R	R	R	R	R	R
Calendula sp.	R	R	R	R	R	R	R	R
Chenopodium ambrosoides	R	R	R	R	R	R	R	R
Chrysanthemum sp.	R	R	R	R	R	R	R	R
Cosmos sp.	R	R	R	R	R	R	R	R
Dahlia sp.	R	R	R	R	R	R	R	R
Helianthus annuus	R	R	R	R	R	R	R	R
Plantago rugelii	R	R	R	R	R	R	R	R
Sonchus sp.	R	R	R	R	R	R	R	R
Nicotiana tabaccum	R	R	R	R	R	R	R	R
Xanthium strumarium	R	R	R	R	R	R	R	R
Zinnia elegans	R	R	R	R	R	R	R	R

* R = Resistant
S = Susceptible

TABLE 8

Reaction of some cultivated cucurbits against S. fuliginea obtained from non-cucurbits when inoculated plants are grown either in glasshouse or in the field.

Plants inoculated	*Reaction against isolates									
	A.esculentus		S.melongena		H. annuus		Z.elegans		X.strumarium	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Benincasa hispida	R	R	R	R	R	R	R	R	R	R
Citrullus vulgaris	R	R	R	R	R	R	R	R	R	R
C. vulgaris var. fistulosus	R	R	R	R	R	R	R	R	R	R
Cucurbita maxima	R	R	R	R	R	R	R	R	R	R
C. moschata	R	R	R	R	R	R	R	R	R	R
C. pepo	R	R	R	R	R	R	R	R	R	R
Cucumis melo	R	R	R	R	R	R	R	R	R	R
C. melo var. momordica	R	R	R	R	R	R	R	R	R	R
C. melo var. utilissimus	R	R	R	R	R	R	R	R	R	R
C. sativus	R	R	R	R	R	R	R	R	R	R
Lagenaria leucantha	R	R	R	R	R	R	R	R	R	R
Luffa acutangula	R	R	R	R	R	R	R	R	R	R
L. cylindrica	R	R	R	R	R	R	R	R	R	R
Momordica charantia	R	R	R	R	R	R	R	R	R	R
Trichosanthes anguina	R	R	R	R	R	R	R	R	R	R
T. dioica	R	R	R	R	R	R	R	R	R	R

* R = Resistant
S = Susceptible
Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 9

Reaction of ten wild cucurbits against *S. fuliginea* obtained from five non-cucurbits when inoculated plants are grown either in glasshouse or in the field.

Wild cucurbits inoculated	*Reaction against isolates									
	A. esculentus		*S. melongena*		*H. annuus*		*Z. elegans*		*X.strumarium*	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Melothria maderaspatana	R	R	R	R	R	R	R	R	R	R
Bryonopsis laciniosa	R	R	R	R	R	R	R	R	R	R
Cucumis anguria	R	R	R	R	R	R	R	R	R	R
C. melo var. *agrestis*	R	R	R	R	R	R	R	R	R	R
Cucurbita ficifolia	R	R	R	R	R	R	R	R	R	R
Luffa echinata	R	R	R	R	R	R	R	R	R	R
L. graveolans	R	R	R	R	R	R	R	R	R	R
Citrullus lanatus	R	R	R	R	R	R	R	R	R	R
Coccinia cordifolia	R	R	R	R	R	R	R	R	R	R
Trichosanthes cucumerina	R	R	R	R	R	R	R	R	R	R

* R = Resistant
S = Susceptible

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 10

Reaction of fourteen non-cucurbits against *S. fuliginea* obtained from non-cucurbits when inoculated plants are grown either in glasshouse or in the field.

Plants inoculated	* Reaction against isolates									
	A. esculentus		*S.melongena*		*H. annuus*		*Z. elegans*		*X.strumarium*	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Abelmoschus esculentus	S	S	R	R	R	R	R	R	R	R
Bellis perennis	R	R	R	R	R	R	R	R	R	R
Calendula sp.	R	R	R	R	R	R	R	R	R	R
Chenopodium ambrosoides	R	R	R	R	R	R	R	R	R	R
Chrysanthemum sp.	R	R	R	R	R	R	R	R	R	R
Cosmos sp.	R	R	R	R	R	R	R	R	R	R
Dahlia sp.	R	R	R	R	R	R	R	R	R	R
Helianthus annuus	R	R	R	R	S	S	R	R	R	R
Plantago rugelii	R	R	R	R	R	R	R	R	R	R
Sonchus sp.	R	R	R	R	R	R	R	R	R	R
Solanum melongena	R	R	S	S	R	R	R	R	R	R
Nicotiana tabacum	R	R	R	R	R	R	R	R	R	R
Xanthium strumarium	R	R	R	R	R	R	R	R	S	S
Zinnia elegans	R	R	R	R	R	R	S	S	R	R

* R = Resistant
S = Susceptible

TABLE 11

Host reaction of five different cultivars of Benincasa hispida against S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	°Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Khola petha$_1$	3	3	3	3	3	3	3	3	3	3
Petha gourd$_1$	3	3	3	3	3	3	3	3	3	3
Petha gourd$_2$	3	3	3	3	3	3	3	3	3	3
Petha gourd$_3$	3	3	3	3	3	3	3	3	3	3
Ash gourd$_1$	3	3	3	3	3	3	3	3	3	3

° Ll_1 Melothria maderaspatana culture 1.
Ll_2 Lagenaria leucantha culture 2.
Cm_1 Cucurbita moschata culture 1.
Cm_2 Cucurbita moschata culture 2.
Lc_1 Luffa cylindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

white seeded$_2$, red seeded$_2$, watermelon$_3$, tarmuj$_1$ soft skin$_1$ and white seeded$_3$ highly resistant in glasshouse.

Infection rating of all the varieties of C. vulgaris against all the cucurbit isolates was the same both in glasshouse and in the field except white seeded$_2$ and soft skin$_1$ which were highly resistant in glasshouse but susceptible in field (Table 12).

Out of the five varieties of C. vulgaris var. fistulosus namely, dilpasand tinda$_1$, dilpasand tinda$_2$ and Lucknow special$_1$ were susceptible and tinda Delhi$_1$ and gourd tinda$_1$ highly resistant in glasshouse against all the five cucurbit isolates. However, in the field even the susceptible varieties became moderately resistant and those which were moderately resistant became highly resistant (Table 13). Thirty varieties of C. melo grown locally (District Aligarh) and are agronomically different from the above and arbitrarily designated as local$_1$ and local$_{30}$ proved to be highly susceptible to all the five cucurbit isolates both in the glasshouse and field (Table 14).

Out of twenty eight indigenous varieties of C. melo, muskmelon$_6$ was highly resistant; Faizabadi$_3$, mixed$_1$ and model$_1$ were resistant; Faizabadi$_2$, Kharra$_2$, honey sugar rock$_2$ and plain sweet$_1$ moderately resistant, dharidar$_1$ and Jaunpuri$_2$ susceptible and delicious$_1$, Faizabadi$_1$, honey sugar rock$_1$, Jaunpuri$_1$, Kharra$_1$, Lucknow$_1$, Lucknow$_2$, Lucknow$_3$, Lucknow$_4$,

Table 12

Host reaction of twenty five different cultivars of Citrullus vulgaris against S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	Reaction against isolates									
	°Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Red seeded$_1$	4	4	4	4	4	4	4	4	4	4
Jaunpuri$_1$	4	4	4	4	4	4	4	4	4	4
Allahabadi$_1$	2	2	2	2	2	2	2	2	2	2
Bareilly Kalan$_1$	2	2	2	2	2	2	2	2	2	2
Black seeded$_1$	2	2	2	2	2	2	2	2	2	2
Faizabadi$_1$	2	2	2	2	2	2	2	2	2	2
Faizabadi$_2$	2	2	2	2	2	2	2	2	2	2
Farrukhabadi$_1$	2	2	2	2	2	2	2	2	2	2
Sugar sweet$_1$	2	2	2	2	2	2	2	2	2	2
Water melon$_1$	2	2	2	2	2	2	2	2	2	2
Hard skin$_1$	1	1	1	1	1	1	1	1	1	1
Water melon$_2$	1	1	1	1	1	1	1	1	1	1
White seeded$_1$	1	1	1	1	1	1	1	1	1	1
Farrukhabadi$_2$	0	0	0	0	0	0	0	0	0	0
Indian green$_1$	0	0	0	0	0	0	0	0	0	0
Jaunpuri$_2$	0	0	0	0	0	0	0	0	0	0
Mixed$_1$	0	0	0	0	0	0	0	0	0	0
Midget$_1$	0	0	0	0	0	0	0	0	0	0
Quatar gola$_1$	0	0	0	0	0	0	0	0	0	0
White seeded$_2$	0	3	0	3	0	3	0	3	0	3
Red seeded$_2$	0	0	0	0	0	0	0	0	0	0
Water melon$_3$	0	0	0	0	0	0	0	0	0	0
Tarmuj$_1$	0	0	0	0	0	0	0	0	0	0
Soft skin$_1$	0	3	0	3	0	3	0	3	0	3
White seeded$_3$	0	0	0	0	0	0	0	0	0	0

°Ll_1=Melothria maderaspatana culture 1.
Ll_2=Lagenaria leucantha culture 2.
Cm_1=Cucurbita moschata culture 1.
Cm_2=Cucurbita moschata culture 2.
Lc_1=Luffa cyclindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 13

Host reaction of five different cultivars of C. vulgaris var. fistulosus against S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	*Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Dilpasand tinda$_1$	3	2	3	2	3	2	3	2	3	2
Dilpasand tinda$_2$	3	2	3	2	3	2	3	2	3	2
Lucknow special$_1$	3	1	3	1	3	1	3	1	3	1
Tinda Delhi$_1$	1	0	1	0	1	0	1	0	1	0
Gourd tinda$_1$	0	0	0	0	0	0	0	0	0	0

* Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

*Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 14

Reaction of thirty local collections of Cucumis melo against S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	*Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Local 1	4	4	4	4	4	4	4	4	4	4
Local 2	4	4	4	4	4	4	4	4	4	4
Local 3	4	4	4	4	4	4	4	4	4	4
Local 4	4	4	4	4	4	4	4	4	4	4
Local 5	3	3	3	3	3	3	3	3	3	3
Local 6	4	4	4	4	4	4	4	4	4	4
Local 7	3	3	3	3	3	3	3	3	3	3
Local 8	4	4	4	4	4	4	4	4	4	4
Local 9	4	4	4	4	4	4	4	4	4	4
Local 10	4	4	4	4	4	4	4	4	4	4
Local 11	4	4	4	4	4	4	4	4	4	4
Local 12	4	4	4	4	4	4	4	4	4	4
Local 13	4	4	4	4	4	4	4	4	4	4
Local 14	3	3	3	3	3	3	3	3	3	3
Local 15	4	4	4	4	4	4	4	4	4	4
Local 16	4	4	4	4	4	4	4	4	4	4
Local 17	4	4	4	4	4	4	4	4	4	4
Local 18	4	4	4	4	4	4	4	4	4	4
Local 19	4	4	4	4	4	4	4	4	4	4
Local 20	4	4	4	4	4	4	4	4	4	4
Local 21	4	4	4	4	4	4	4	4	4	4
Local 22	4	4	4	4	4	4	4	4	4	4
Local 23	4	4	4	4	4	4	4	4	4	4
Local 24	4	4	4	4	4	4	4	4	4	4
Local 25	4	4	4	4	4	4	4	4	4	4
Local 26	4	4	4	4	4	4	4	4	4	4
Local 27	4	4	4	4	4	4	4	4	4	4
Local 28	4	4	4	4	4	4	4	4	4	4
Local 29	4	4	4	4	4	4	4	4	4	4
Local 30	4	4	4	4	4	4	4	4	4	4

*Ll_1 Melothria maderaspatana culture 1.
Ll_2 Lagenaria leucantha culture 2.
Cm_1 Cucurbita moschata culture 1.
Cm_2 Cucurbita moschata culture 2.
Lc_1 Luffa cylindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

Lucknow$_5$, Lucknow sweet$_1$, muskmelon$_1$, muskmelon$_2$, muskmelon$_3$, muskmelon$_4$, muskmelon$_5$, Roys$_1$ and solid rock$_1$ highly susceptible. Infection rating of all varieties of C. melo against all the cucurbit isolates in field was the same as in glasshouse except that Faizabadi$_3$, mixed$_1$ and model$_1$ were resistant in glasshouse but highly susceptible in the field (Table 15).

Varieties of C. melo obtained from the U.S.A. where they are used as differentials for distinguishing the races of Erysiphe cichoracearum viz. Delicious$_{51}$ and Spartan rock were highly susceptible; Edisto 47, Campo, Hales Best 36, Jacumba, PMR$_6$ and PMR$_{45}$ were susceptible both in glasshouse and field against all the cucurbit isolates of S. fuliginea (Fig. 7, Table 16).

The infection rating of different varieties of C. melo var. momordica viz. large$_1$, long$_1$, small$_1$ and phoont$_1$ was 4, 3, 2 and 2 respectively in glasshouse; however, in the field all the varieties were highly susceptible as in each case the infection rating was 4 (Table 17).

Out of the sixteen varieties of C. melo var. utilissimus, hot season$_1$, hirvi$_1$, Jaunpuri$_1$, kakri$_1$ and Lucknow$_1$ were susceptible; Lucknow geteer$_1$ and white long Faizabadi$_1$ were moderately resistant; kakri$_2$, Lucknow$_2$ and melon kakri$_1$ were resistant; hot-season$_2$, kakri$_3$, Lucknow$_3$, melon kankur$_1$, phoont$_1$

TABLE 15

Host reaction of twenty eight different cultivars of Cucumis melo against S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	°Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
$Delicious_1$	4	4	4	4	4	4	4	4	4	4
$Faizabadi_1$	4	4	4	4	4	4	4	4	4	4
$Honey\ sugar\text{-}rock_1$	4	4	4	4	4	4	4	4	4	4
$Jaunpuri_1$	4	4	4	4	4	4	4	4	4	4
$Kharra_1$	4	4	4	4	4	4	4	4	4	4
$Lucknow_1$	4	4	4	4	4	4	4	4	4	4
$Lucknow_2$	4	4	4	4	4	4	4	4	4	4
$Lucknow_3$	4	4	4	4	4	4	4	4	4	4
$Lucknow_4$	4	4	4	4	4	4	4	4	4	4
$Lucknow_5$	4	4	4	4	4	4	4	4	4	4
$Lucknow\ sweet_1$	4	4	4	4	4	4	4	4	4	4
$Muskmelon_1$	4	4	4	4	4	4	4	4	4	4
$Muskmelon_2$	4	4	4	4	4	4	4	4	4	4
$Muskmelon_3$	4	4	4	4	4	4	4	4	4	4
$Muskmelon_4$	4	4	4	4	4	4	4	4	4	4
$Muskmelon_5$	4	4	4	4	4	4	4	4	4	4
$Roys_1$	4	4	4	4	4	4	4	4	4	4
$Solid\ rock_1$	4	4	4	4	4	4	4	4	4	4
$Dharidar_1$	3	3	3	3	3	3	3	3	3	3
$Jaunpuri_2$	3	4	3	4	3	4	3	4	3	4
$Faizabadi_2$	2	2	2	2	2	2	2	2	2	2
$Kharra_2$	2	4	2	4	2	4	2	4	2	4
$Honey\ sugar\ rock_2$	2	4	2	4	2	4	2	4	2	4
$Plain\ sweet_1$	2	2	2	2	2	2	2	2	2	2
$Faizabadi_3$	1	4	1	4	1	4	1	4	1	4
$Mixed_1$	1	4	1	4	1	4	1	4	1	4
$Model_1$	1	4	1	4	1	4	1	4	1	4
$Muskmelon_6$	0	0	0	0	0	0	0	0	0	0

°Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* Highly susceptible = 4.
Susceptible = 3.
Moderately resistant = 2.
Resistant = 1.
Highly resistant = 0.

Temperature range in glass house = 8-1
Temperature range in field = 18-22°C

TABLE 16

Reaction of eight differentials of Cucumis melo obtained from U.S.D.A. against S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	*Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Delicious 51	4	4	4	4	4	4	4	4	4	4
Spartan rock	4	4	4	4	4	4	4	4	4	4
Edisto 47	3	3	3	3	3	3	3	3	3	3
Campo	3	3	3	3	3	3	3	3	3	3
Hales Best No. 36	3	3	3	3	3	3	3	3	3	3
Jacumba	3	3	3	3	3	3	3	3	3	3
PMR_6	3	3	3	3	3	3	3	3	3	3
PMR_{45}	3	3	3	3	3	3	3	3	3	3

*Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 17

Reaction of four different cultivars of C. melo var. momordica against S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	* Reaction against isolates									
	°Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
$Large_1$	4	4	4	4	4	4	4	4	4	4
$Long_1$	3	4	3	4	3	4	3	4	3	4
$Small_1$	2	4	2	4	2	4	2	4	2	4
$Phoont_1$	2	4	2	4	2	4	2	4	2	4

°Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately = 2
Resistant = 1
Highly resistant = 0

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

Fig. 7. Foreign cantaloupes infected with *S. fuliginea*.

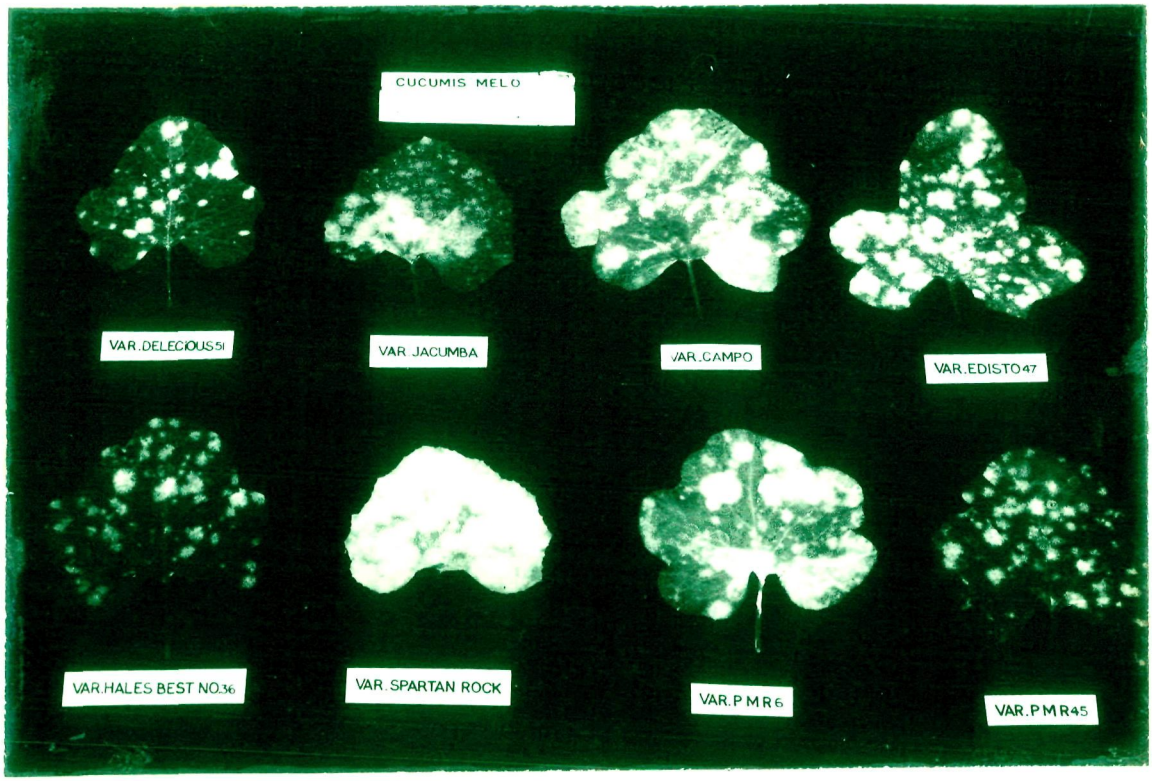
CUCUMIS MELO
VAR. DELECIOUS 51
VAR. JACUMBA
VAR. CAMPO
VAR. EDISTO 47
VAR. HALES BEST NO. 36
VAR. SPARTAN ROCK
VAR. P M R 6
VAR. P M R 45

FIG. 7

and white long Lucknow$_1$ highly resistant in glasshouse. Host response of all the varieties of C. melo var. utilissimus against all the five cucurbit isolates was the same both in field and in glasshouse except that Lucknow getaer$_1$ moderately resistant and melon kakri$_1$, resistant in glasshouse but highly susceptible in field (Table 18).

C. sativus varieties, all season$_1$, early$_1$, hot season$_1$, improved long green$_1$, Indian$_1$, kheera$_1$, kheera$_2$, kheera$_3$, kheera$_4$, long$_1$, long$_2$, long green$_1$, long summer$_1$, Lucknowi$_1$, rainy season$_1$, Poona kheera$_1$ and Lucknow$_1$ were highly susceptible both in glasshouse and in field against all the five cucurbit isolates. Khunya$_1$ was moderately resistant in glasshouse only, Kashmiri long$_1$ both in glasshouse and the field and variety short green$_1$ highly resistant in both (Table 19).

Both the varieties of C. maxima$_1$ and 2 proved to be highly resistant against all the five cucurbit isolates in the glasshouse as well as in the field.

Out of six varieties of C. moschata, early white bush$_1$, English marrow$_1$ and vegetable marrow$_1$ were highly susceptible; bright red$_1$ variety susceptible; red large$_1$ and white bush$_1$, moderately resistant only in glasshouse. In the field, on the

TABLE 18

Reaction of sixteen different cultivars of C. melo var. utilissimus against S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	*Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Hot season$_1$	3	3	3	3	3	3	3	3	3	3
Hirvi$_1$	3	3	3	3	3	3	3	3	3	3
Jaunpuri$_1$	3	3	3	3	3	3	3	3	3	3
Kakri$_1$	3	3	3	3	3	3	3	3	3	3
Lucknow$_1$	3	3	3	3	3	3	3	3	3	3
Lucknow geteer$_1$	2	3	2	3	2	3	2	3	2	3
White long Faizabadi$_1$	2	2	2	2	2	2	2	2	2	2
Kakri$_2$	1	1	1	1	1	1	1	1	1	1
Lucknow$_2$	1	1	1	1	1	1	1	1	1	1
Melon kakri$_1$	1	2	1	2	1	2	1	2	1	2
Hot season$_2$	0	0	0	0	0	0	0	0	0	0
Kakri$_3$	0	0	0	0	0	0	0	0	0	0
Lucknow$_3$	0	0	0	0	0	0	0	0	0	0
Melon kankur$_1$	0	0	0	0	0	0	0	0	0	0
Phoont$_1$	0	0	0	0	0	0	0	0	0	0
White long Lucknow$_1$	0	0	0	0	0	0	0	0	0	0

*Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 19

Reaction of twenty different cultivars of Cucumis sativus against S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
All season$_1$	4	3	4	3	4	3	4	3	4	3
Early$_1$	4	3	4	3	4	3	4	3	4	3
Hot season$_1$	4	3	4	3	4	3	4	3	4	3
Improved long green$_1$	4	3	4	3	4	3	4	3	4	3
Indian$_1$	4	3	4	3	4	3	4	3	4	3
Kheera$_1$	4	3	4	3	4	3	4	3	4	3
Kheera$_2$	4	3	4	3	4	3	4	3	4	3
Kheera$_3$	4	3	4	3	4	3	4	3	4	3
Kheera$_4$	4	3	4	3	4	3	4	3	4	3
Long$_1$	4	3	4	3	4	3	4	3	4	3
Long$_2$	4	3	4	3	4	3	4	3	4	3
Long green$_1$	4	3	4	3	4	3	4	3	4	3
Long summer$_1$	4	3	4	3	4	3	4	3	4	3
Lucknow$_1$	4	3	4	3	4	3	4	3	4	3
Rainy season$_1$	4	3	4	3	4	3	4	3	4	3
Poona kheera$_1$	4	3	4	3	4	3	4	3	4	3
Lucknow$_1$	4	3	4	3	4	3	4	3	4	3
Bhunya$_1$	2	2	2	2	2	2	2	2	2	2
Kashmiri long$_1$	2	2	2	2	2	2	2	2	2	2
Short green$_1$	0	0	0	0	0	0	0	0	0	0

* Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

other hand, all of them were highly susceptible.

C. nano$_1$ of Sheela seeds was highly susceptible against all the five cucurbit isolates in glasshouse as well as in field tests (Table 20).

Varieties of L. leucantha viz. doodhi long$_1$, doodhi long summer$_1$, doodhi round$_1$, lauki Singapuri$_1$, bottle gourd$_1$, long white$_1$, lauki long$_1$, ribbed long green$_1$, long thin variety$_1$, lauki long$_2$ and lauki round$_1$ were highly susceptible to all the five cucurbit isolates both in glasshouse and field tests (Table 21).

Black seeded$_1$, jhinga turai$_1$, jhinga baropata$_1$ and jhinga bhunya$_1$ varieties of L. acutangula proved to be highly susceptible in glasshouse. So was the case with all the varieties namely all season$_1$, ghia turai$_1$, ghia turai$_2$, small green$_1$ and long green$_1$ of L. cylindrica (Table 22).

It is interesting to note that unlike other cucurbits L. acutangula and L. cylindrica which were highly susceptible in glasshouse proved to be moderately resistant in the field against all the five cucurbit isolates of S. fuliginea (Table 22)

All the varieities of M. charantia were highly resistant to Ll$_2$, Cm$_1$, Cm$_2$ and Lc$_1$ isolates except Ll$_1$ isolate to which all season$_1$, Faizabadi$_1$ and long$_1$ were susceptible; long green$_1$ and karela$_1$ moderately resistant; karela$_2$, rainy season$_1$ and

TABLE 20

Reaction of six different cultivars of Cucurbita moschata, one of C. pepo and one of C. maxima against E. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
C. moschata										
Early white bush$_1$	4	4	4	4	4	4	4	4	4	4
English marrow$_1$	4	4	4	4	4	4	4	4	4	4
Vegetable marrow$_1$	4	4	4	4	4	4	4	4	4	4
Bright red$_1$	3	4	3	4	3	4	3	4	3	4
Red large$_1$	2	4	2	4	2	4	2	4	2	4
White bush$_1$	2	4	2	4	2	4	2	4	2	4
C. pepo$_1$	4	4	4	4	4	4	4	4	4	4
C. maxima$_1$	0	0	0	0	0	0	0	0	0	0

*Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 21

Reaction of eleven different cultivars of Lagenaria leuchanta against S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties.	* Reaction against isolates									
	Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Doodhi $long_1$	4	4	4	4	4	4	4	4	4	4
Doodhi $long^1 summer_1$	4	4	4	4	4	4	4	4	4	4
Doodhi $round_1$	4	4	4	4	4	4	4	4	4	4
Lauki $Singapuri_1$	4	4	4	4	4	4	4	4	4	4
Bottle $gourd_1$	4	4	4	4	4	4	4	4	4	4
Long $white_1$	4	4	4	4	4	4	4	4	4	4
Lauki $long_1$	4	4	4	4	4	4	4	4	4	4
Ribbed $long^1 green_1$	4	4	4	4	4	4	4	4	4	4
Long thin $variety_1$	4	4	4	4	4	4	4	4	4	4
Lauki $long_2$	4	4	4	4	4	4	4	4	4	4
Lauki $round_1$	4	4	4	4	4	4	4	4	4	4

*Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 22

Reaction of four different cultivars of Luffa acutangula and five of L. cylindrica against S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	°Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
L. acutangula										
Black seeded$_1$	4	2	4	2	4	2	4	2	4	2
Jhinga turai$_1$	4	2	4	2	4	2	4	2	4	2
Jhinga baropata$_1$	4	2	4	2	4	2	4	2	4	2
Jhinga bhunya$_1$	4	2	4	2	4	2	4	2	4	2
L. cylindrica										
All season$_1$	4	2	4	2	4	2	4	2	4	2
Ghia turai$_1$	4	2	4	2	4	2	4	2	4	2
Ghia turai$_2$	4	2	4	2	4	2	4	2	4	2
Small green$_1$	4	2	4	2	4	2	4	2	4	2
Long green$_1$	4	2	4	2	4	2	4	2	4	2

°Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

summer crop$_1$ resistant in glasshouse. In the field all of them were moderately susceptible (Table 23).

All the eleven varieties of T. anguina viz. all season$_1$, extra long special$_1$, chichinga gourd$_1$, Globe phone$_1$, black$_1$, long green$_1$, white$_1$, white$_2$, snake gourd$_1$ and snake gourd$_2$ proved to be susceptible to moderately resistant in glasshouse but remained highly resistant in field (Table 24).

All the varieties of B. hispida, C. vulgaris, C. vulgaris var. fistulosus, C. melo, C. melo var. momordica, C. melo var. utilissimus, C. sativus, C. maxima, C. moschata, C. pepo, L. leucantha, L. acutangula, L. cylindrica, M. charantia and T. anguina proved to be highly resistant both in glasshouse and field tests against the five non-cucurbit isolates (Tables 25-38)

Formation of perithecia:-

The data pertaining to the varieties which supported the formation of perithecia is summarised in Table 39(a). It is clear that only one variety out of the six of C. moschata; six out of twenty vars., of C. sativus; only one out of twentyeight vars. of C. melo; two out of sixteen vars. of C. melo var. utilissimus; only one out of four vars. of C. melo var. momordica; four out of twenty five vars. of C. vulgaris; three out of eleven vars., of L. leucantha; only one out of

TABLE 23

Reaction of eight different cultivars of Momordica charantia against S. fuliginea when inoculated plants are grown in glasshouse or in the field.

Varieties	*Reaction against isolates									
	°Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
All season$_1$	3	2	0	0	0	0	0	0	0	0
Faizabadi$_1$	3	2	0	0	0	0	0	0	0	0
Long$_1$	3	2	0	0	0	0	0	0	0	0
Long green$_1$	2	2	0	0	0	0	0	0	0	0
Karela$_1$	2	2	0	0	0	0	0	0	0	0
Karela$_2$	1	2	0	0	0	0	0	0	0	0
Rainy Season$_1$	1	2	0	0	0	0	0	0	0	0
Summer crop$_1$	1	2	0	0	0	0	0	0	0	0

°Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 24

Reaction of eleven different cultivars of *Trichosanthes anguina* against *S. fulisinea* when inoculated plants are grown in glasshouse or in the field.

Varieties	*Reaction against isolates									
	*Ll_1		Ll_2		Cm_1		Cm_2		Lc_1	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
All season$_1$	3	0	0	0	0	0	0	0	0	0
Extra long$_1$	3	0	0	0	0	0	0	0	0	0
Extra long special$_1$	3	0	0	0	0	0	0	0	0	0
Chichinga gourd$_1$	3	0	0	0	0	0	0	0	0	0
Globe phone$_1$	3	0	0	0	0	0	0	0	0	0
Black$_1$	3	0	0	0	0	0	0	0	0	0
Long green$_1$	3	0	0	0	0	0	0	0	0	0
White$_1$	3	0	0	0	0	0	0	0	0	0
White$_2$	2	0	0	0	0	0	0	0	0	0
Snake gourd$_1$	2	0	0	0	0	0	0	0	0	0
Snake gourd$_2$	2	0	0	0	0	0	0	0	0	0

*Ll_1 = *Melothria maderaspatana* culture 1.
Ll_2 = *Lagenaria leucantha* culture 2.
Cm_1 = *Cucurbita moschata* culture 1.
Cm_2 = *Cucurbita moschata* culture 2.
Lc_1 = *Luffa cylindrica* culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 25

Response of five different cultivars of Benincasa hispida against non-cucurbit isolates of S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	A.esculentus		S.melongena		H. annuus		X.strumarium		Z.elegans	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Khola petha$_1$	0	0	0	0	0	0	0	0	0	0
Petha gourd$_1$	0	0	0	0	0	0	0	0	0	0
Petha gourd$_2$	0	0	0	0	0	0	0	0	0	0
Petha gourd$_3$	0	0	0	0	0	0	0	0	0	0
Ash gourd$_1$	0	0	0	0	0	0	0	0	0	0

* 0 = Highly resistant.

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 26

Reaction of twenty five different cultivars of Citrullus vulgaris against non-cucurbit isolates of S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	A.esculentus		S. melongena		H. annuus		X.strumarium		Z. elegans	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Red seeded$_1$	0	0	0	0	0	0	0	0	0	0
Jaunpuri$_1$	0	0	0	0	0	0	0	0	0	0
Allahabadi$_1$	0	0	0	0	0	0	0	0	0	0
Bareilly Kalan$_1$	0	0	0	0	0	0	0	0	0	0
Black seeded$_1$	0	0	0	0	0	0	0	0	0	0
Faizabadi$_1$	0	0	0	0	0	0	0	0	0	0
Faizabadi$_2$	0	0	0	0	0	0	0	0	0	0
Farrukhabadi$_1$	0	0	0	0	0	0	0	0	0	0
Sugar sweet$_1$	0	0	0	0	0	0	0	0	0	0
Watermelon$_1$	0	0	0	0	0	0	0	0	0	0
Hard skin$_1$	0	0	0	0	0	0	0	0	0	0
Watermelon$_2$	0	0	0	0	0	0	0	0	0	0
White seeded$_1$	0	0	0	0	0	0	0	0	0	0
Farrukhabadi$_2$	0	0	0	0	0	0	0	0	0	0
Indian green$_1^2$	0	0	0	0	0	0	0	0	0	0
Jaunpuri$_2$	0	0	0	0	0	0	0	0	0	0
Mixed$_1$	0	0	0	0	0	0	0	0	0	0
Midget$_1$	0	0	0	0	0	0	0	0	0	0
Quatargola$_1$	0	0	0	0	0	0	0	0	0	0
White seeded$_2$	0	0	0	0	0	0	0	0	0	0
Red seeded$_2$	0	0	0	0	0	0	0	0	0	0
Watermelon$_3$	0	0	0	0	0	0	0	0	0	0
Tarmuj$_1$	0	0	0	0	0	0	0	0	0	0
Soft skin$_1$	0	0	0	0	0	0	0	0	0	0
White seeded$_3$	0	0	0	0	0	0	0	0	0	0

* 0 = Highly resistant
Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 27

Reaction of five different cultivars of C. vulgaris var. fistulosus against non-cucurbit isolates of S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	A.esculentus		S.melongena		H.annuus		X.strumarium		Z.elegans	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Dilpasand tinda$_1$	0	0	0	0	0	0	0	0	0	0
Dilpasand tinda$_2$	0	0	0	0	0	0	0	0	0	0
Lucknow special$_1$	0	0	0	0	0	0	0	0	0	0
Tinda Delhi$_1$	0	0	0	0	0	0	0	0	0	0
Gourd tinda$_1$	0	0	0	0	0	0	0	0	0	0

* 0 = Highly resistant

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 28

Reaction of thirty different cultivars of C. melo against non-cucurbit isolates of S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	A.esculentus		S.melongena		H. annuus		X.strumarium		Z.elegans	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
$Local_1$	0	0	0	0	0	0	0	0	0	0
$Local_2$	0	0	0	0	0	0	0	0	0	0
$Local_3$	0	0	0	0	0	0	0	0	0	0
$Local_4$	0	0	0	0	0	0	0	0	0	0
$Local_5$	0	0	0	0	0	0	0	0	0	0
$Local_6$	0	0	0	0	0	0	0	0	0	0
$Local_7$	0	0	0	0	0	0	0	0	0	0
$Local_8$	0	0	0	0	0	0	0	0	0	0
$Local_9$	0	0	0	0	0	0	0	0	0	0
$Local_{10}$	0	0	0	0	0	0	0	0	0	0
$Local_{11}$	0	0	0	0	0	0	0	0	0	0
$Local_{12}$	0	0	0	0	0	0	0	0	0	0
$Local_{13}$	0	0	0	0	0	0	0	0	0	0
$Local_{14}$	0	0	0	0	0	0	0	0	0	0
$Local_{15}$	0	0	0	0	0	0	0	0	0	0
$Local_{16}$	0	0	0	0	0	0	0	0	0	0
$Local_{17}$	0	0	0	0	0	C	0	0	0	0
$Local_{18}$	0	0	0	0	0	0	0	0	0	0
$Local_{19}$	0	0	0	0	0	0	0	0	0	0
$Local_{20}$	0	0	0	0	0	0	0	0	0	0
$Local_{21}$	0	0	0	0	0	0	0	0	0	0
$Local_{22}$	0	0	0	0	0	0	0	0	0	0
$Local_{23}$	0	0	0	0	0	0	0	0	0	0
$Local_{24}$	0	0	0	0	0	0	0	0	0	0
$Local_{25}$	0	0	0	0	0	0	0	0	0	0
$Local_{26}$	0	0	0	0	0	0	0	C	0	0
$Local_{27}$	0	0	0	0	0	0	0	0	0	0
$Local_{28}$	0	0	0	0	0	0	0	0	0	0
$Local_{29}$	0	0	0	0	0	0	0	0	0	0
$Local_{30}$	0	0	0	0	0	0	0	0	0	0

* 0 = Highly resistant

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 29

Reaction of twenty eight different cultivars of *Cucumis melo* against non-cucurbit isolates of *S. fuliginea* when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	A.esculentus		*S.melongena*		*H.annuus*		*X.strumarium*		*Z.elegans*	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Delicious$_1$	0	0	0	0	0	0	0	0	0	0
Faizabadi$_1$	0	0	0	0	0	0	0	0	0	0
Honey sugar rock$_1$	0	0	0	0	0	0	0	0	0	0
Jaunpuri$_1$	0	0	0	0	0	0	0	0	0	0
Kharra$_1$	0	0	0	0	0	0	0	0	0	0
Lucknow$_1$	0	0	0	0	0	0	0	0	0	0
Lucknow$_2$	0	0	0	0	0	0	0	0	0	0
Lucknow$_3$	0	0	0	0	0	0	0	0	0	0
Lucknow$_4$	0	0	0	0	0	0	0	0	0	0
Lucknow$_5$	0	0	0	0	0	0	0	0	0	0
Lucknow sweet$_1$	0	0	0	0	0	0	0	0	0	0
Muskmelon$_1$	0	0	0	0	0	0	0	0	0	0
Muskmelon$_2$	0	0	0	0	0	0	0	0	0	0
Muskmelon$_3$	0	0	0	0	0	0	0	0	0	0
Muskmelon$_4$	0	0	0	0	0	0	0	0	0	0
Muskmelon$_5$	0	0	0	0	0	0	0	0	0	0
Roys$_1$	0	0	0	0	0	0	0	0	0	0
Solid rock$_1$	0	0	0	0	0	0	0	0	0	0
Dharidar$_1$	0	0	0	0	0	0	0	0	0	0
Jaunpuri$_2$	0	0	0	0	0	0	0	0	0	0
Faizabadi$_2$	0	0	0	0	0	0	0	0	0	0
Kharra$_2$	0	0	0	0	0	0	0	0	0	0
Honey sugar rock$_2$	0	0	0	0	0	0	0	0	0	0
Plain sweet$_1$	0	0	0	0	0	0	0	0	0	0
Faizabadi$_3$	0	0	0	0	0	0	0	0	0	0
Mixed$_1$	0	0	0	0	0	0	0	0	0	0
Model$_1$	0	0	0	0	0	0	0	0	0	0
Muskmelon$_6$	0	0	0	0	0	0	0	0	0	0

* 0= Highly resistant

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 30

Reaction of eight different cultivars of C. melo (U.S.A.) against non-cucurbit isolates of E. fuliginea when inoculated plants are grown in glasshouse or in the field

Varieties	*Reaction against isolates									
	A.esculentus		S.melongena		H. annuus		X.strumarium		Z.elegans	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Delicious 51	0	0	0	0	0	0	0	0	0	0
Spartan rock	0	0	0	0	0	0	0	0	0	0
Edisto 47	0	0	0	0	0	0	0	0	0	0
Campo	0	0	0	0	0	0	0	0	0	0
Hales best No. 36	0	0	0	0	0	0	0	0	0	0
Jacumba	0	0	0	0	0	0	0	0	0	0
PMR_6	0	0	0	0	0	0	0	0	0	0
PMR_{45}	0	0	0	0	0	0	0	0	0	0

* 0 = Highly resistant

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 31

Reaction of four different cultivars of C. melo var. momordica against non-cucurbit isolates of S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	A.esculentus		S.melongena		H. annuus		X.strumarium		Z. elegans	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Large$_1$	0	0	0	0	0	0	0	0	0	0
Long$_1$	0	0	0	0	0	0	0	0	0	0
Small$_1$	0	0	0	0	0	0	0	0	0	0
Phoont$_1$	0	0	0	0	0	0	0	0	0	0

* 0 = Highly resistant

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 32

Reaction of sixteen different cultivars of C. melo var. utilissimus against non-cucurbit isolates of S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	A.esculentus		S.melongena		H. annuus		X.strumarium		Z. elegans	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Hot season$_1$	0	0	0	0	0	0	0	0	0	0
Hirvi$_1$	0	0	0	0	0	0	0	0	0	0
Jaunpuri$_1$	0	0	0	0	0	0	0	0	0	0
Kakri$_1$	0	0	0	0	0	0	0	0	0	0
Lucknow$_1$	0	0	0	0	0	0	0	0	0	0
Lucknow geteer$_1$	0	0	0	0	0	0	0	0	0	0
White long Faizabadi$_1$	0	0	0	0	0	0	0	0	0	0
Kakri$_2$	0	0	0	0	0	0	0	0	0	0
Lucknow$_2$	0	0	0	0	0	0	0	0	0	0
Melon kankur$_1$	0	0	0	0	0	0	0	0	0	0
Kakri phoont$_1$	0	0	0	0	0	0	0	0	0	0
Hot season$_2$	0	0	0	0	0	0	0	0	0	0
Melon kakri$_1$	0	0	0	0	0	0	0	0	0	0
Kakri$_3$	0	0	0	0	0	0	0	0	0	0
Lucknow$_3$	0	0	0	0	0	0	0	0	0	0
White long Lucknow$_1$	0	0	0	0	0	0	0	0	0	0

* 0 = Highly resistant

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 33

Reaction of twenty different cultivars of C. sativus against non-cucurbit isolates of S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	A.esculentus		S.melongena		H. annuus		X.strumarium		Z. elegans	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
All season$_1$	0	0	0	0	0	0	0	0	0	0
Early$_1$	0	0	0	0	0	0	0	0	0	0
Hot season$_1$	0	0	0	0	0	0	0	0	0	0
Improved long green$_1$	0	0	0	0	0	0	0	0	0	0
Indian$_1$	0	0	0	0	0	0	0	0	0	0
Kheera$_1$	0	0	0	0	0	0	0	0	0	0
Kheera$_2$	0	0	0	0	0	0	0	0	0	0
Kheera$_3$	0	0	0	0	0	0	0	0	0	0
Kheera$_4$	0	0	0	0	0	0	0	0	0	0
Long$_1$	0	0	0	0	0	0	0	0	0	0
Long$_2$	0	0	0	0	0	0	0	0	0	0
Long green$_1$	0	0	0	0	0	0	0	0	0	0
Long summer$_1$	0	0	0	0	0	0	0	0	0	0
Lucknowi$_1$	0	0	0	0	0	0	0	0	0	0
Rainy season$_1$	0	0	0	0	0	0	0	0	0	0
Poona kheera$_1$	0	0	0	0	0	0	0	0	0	0
Lucknow$_1$	0	0	0	0	0	0	0	0	0	0
Bhunya$_1$	0	0	0	0	0	0	0	0	0	0
Kashmiri long$_1$	0	0	0	0	0	0	0	0	0	0
Short green$_1$	0	0	0	0	0	0	0	0	0	0

* 0 = Highly resistant

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 34

Reaction of six different cultivars of Cucurbita moschata, one of C. pepo and one of C. maxima against non-cucurbit isolates of S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	A.esculentus		S.melongena		H. annuus		X.strumarium		Z. elegans	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
C. moschata										
Early white bush$_1$	0	0	0	0	0	0	0	0	0	0
English marrow$_1$	0	0	0	0	0	0	0	0	0	0
Vegetable marrow$_1$	0	0	0	0	0	0	0	0	0	0
Bright red$_1$	0	0	0	0	0	0	0	0	0	0
Red large$_1$	0	0	0	0	0	0	0	0	0	0
White bush$_1$	0	0	0	0	0	0	0	0	0	0
C. pepo$_1$	0	0	0	0	0	0	0	0	0	0
C. maxima$_1$	0	0	0	0	0	0	0	0	0	0

* 0 = Highly resistant

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 35

Reaction of eleven different cultivars of Lagenaria leucantha against non-cucurbit isolates of S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	A.esculentus		G.melongena		H. annuus		X.strumarium		Z. elegans	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
Doodhi long$_1$	0	0	0	0	0	0	0	0	0	0
Doodhi long summar$_1$	0	0	0	0	0	0	0	0	0	0
Doodhi round$_1$	0	0	0	0	0	0	0	0	0	0
Lauki Singapuri$_1$	0	0	0	0	0	0	0	0	0	0
Bottle gourd$_1$	0	0	0	0	0	0	0	0	0	0
Long white$_1$	0	0	0	0	0	0	0	0	0	0
Lauki long$_1$	0	0	0	0	0	0	0	0	0	0
Ribbed long green$_1$	0	0	0	0	0	0	0	0	0	0
Long thin variety$_1$	0	0	0	0	0	0	0	0	0	0
Lauki long$_2$	0	0	0	0	0	0	0	0	0	0
Lauki round$_1$	0	0	0	0	0	0	0	0	0	0

* 0 = Highly resistant

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 36

Reaction of four different cultivars of Luffa acutangula and five of L. cylindrica against non-cucurbit isolates of S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	A.esculentus		S. melongena		H. annuus		X.strumarium		Z.elegans	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
L. acutangula										
Black seeded$_1$	0	0	0	0	0	0	0	0	0	0
Jhinga turai$_1$	0	0	0	0	0	0	0	0	0	0
Jhinga baropata$_1$	0	0	0	0	0	0	0	0	0	0
Jhinga bhunya$_1$	0	0	0	0	0	0	0	0	0	0
L. cylindrica										
All season$_1$	0	0	0	0	0	0	0	0	0	0
Ghia turai$_1$	0	0	0	0	0	0	0	0	0	0
Ghia turai$_2$	0	0	0	0	0	0	0	0	0	0
Small green$_1$	0	0	0	0	0	0	0	0	0	0
Long green$_1$	0	0	0	0	0	0	0	0	0	0

* 0 = Highly resistant

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 37

Reaction of eight different cultivars of Momordica charantia against non-cucurbit isolates of S. fuliginea when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	A.esculentus		S.melongena		H. annuus		X.strumarium		Z.elegans	
	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field	Glass house	Field
M. charantia										
All season$_1$	0	0	0	0	0	0	0	0	0	0
Faizabadi$_1$	0	0	0	0	0	0	0	0	0	0
Long$_1$	0	0	0	0	0	0	0	0	0	0
Long green$_1$	0	0	0	0	0	0	0	0	0	0
Karela$_1$	0	0	0	0	0	0	0	0	0	0
Karela$_2$	0	0	0	0	0	0	0	0	0	0
Rainy Season$_1$	0	0	0	0	0	0	0	0	0	0
Summer crop$_1$	0	0	0	0	0	0	0	0	0	0

* 0 = Highly resistant

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 38

Reaction of eleven different cultivars of *Trichosanthes anguina* against non-cucurbit isolates of *S. fuliginea* when inoculated plants are grown either in glasshouse or in the field.

Varieties	*Reaction against isolates									
	A.esculentus		*S.melongena*		*H. annuus*		*X.strumarium*		*Z. elegans*	
	Glass	Field	Glass	Field	Glass	Field	Glass	Field	Glass	Field
All season$_1$	0	0	0	0	0	0	0	0	0	0
Extra long$_1$	0	0	0	0	0	0	0	0	0	0
Extra long special$_1$	0	0	0	0	0	0	0	0	0	0
Chinchinga gourd$_1$	0	0	0	0	0	0	0	0	0	0
Globe phone$_1$	0	0	0	0	0	0	0	0	0	0
Black$_1$	0	0	0	0	0	0	0	0	0	0
Long green$_1$	0	0	0	0	0	0	0	0	0	0
White$_1$	0	0	0	0	0	0	0	0	0	0
White$_2$	0	0	0	0	0	0	0	0	0	0
Snake gourd$_1$	0	0	0	0	0	0	0	0	0	0
Snake gourd$_2$	0	0	0	0	0	0	0	0	0	0

* 0 = Highly resistant

Temperature range in glasshouse = 8-18°C
Temperature range in field = 18-22°C

TABLE 39(a)

Formation of perithecia of E. fuliginea on different varieties of some cultivated cucurbits in glasshouse.

Species with varieties	Isolates					Peri-thecia	Ascus	Asco-spores
	Ll_1	Ll_2	Cm_1	Cm_2	Lc_1			
Cucurbita moschata								
var. vegetable marrow$_1$	24	25	23	24	24	P	P	P
Cucumis sativus								
var.Poona kheera$_1$	22	23	24	23	23	P	P	P
var.Saharanpur long green$_1$	24	25	24	21	24	P	P	P
var.Rainy season$_1$	25	24	25	24	25	P	P	P
var.All season$_1$	23	22	22	23	23	P	P	P
var.Improved long green$_1$	24	25	23	24	24	P	P	P
var.Jaunpuri$_1$	21	22	22	23	21	P	P	P
C. melo								
var.Lucknow$_1$	20	22	22	23	20	P	A	A
C. melo var. utilissimus								
var.Lucknow geteer$_1$	22	23	24	23	23	P	P	A
var.White long Faizabaii$_1$	25	24	24	25	25	P	P	A
C. melo var. momordica								
var. Phoont$_1$	22	23	24	23	23	P	P	P

TABLE 39(a) contd.

Species with varieties	Isolates					Peri-thecia	Ascus	Asco-spores
	Ll_1	Ll_2	Cm_1	Cm_2	Lc_1			
Citrullus vulgaris								
Var. Jaunpuri$_1$	22	22	23	22	23	P	P	P
Var. Red seeded$_1$	25	24	25	24	24	P	P	P
Var. Allahabadi$_1$	20	21	20	21	22	P	P	P
Var. Farrukhabadi$_1$	22	21	20	22	22	P	P	P
Lagenaria leucantha								
Var. Doodhi long$_1$	25	24	24	24	25	P	P	P
Var. Doodhi round$_1$	24	23	23	24	24	P	P	P
Var. Ribbed long green$_1$	21	20	22	21	20	P	P	P
Luffa cylindrica								
Var. All season$_1$	25	24	24	25	25	P	P	P

° Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

Figures indicated the time required for the production of perithecia.

P = Present
A = Absent

five vars. of L. cylindrica supported the formation of perithecia of S. fuliginea. Perithecial formation failed to occur on English marrow$_1$, bright red$_1$, red large$_1$, white bush$_1$ vars. of C. moschata; on early$_1$ hot season$_1$, Indian$_1$, kheera$_1$, kheera$_2$, kheera$_3$, kheera$_4$, long$_1$, long$_2$, long green$_1$, long summer$_1$, Lucknowi$_1$, Lucknow$_1$, bhunya$_1$, Kashmiri long$_1$, short green$_1$ of C. sativus; on delicious$_1$, Faizabadi$_1$, honey sugar rock$_1$, Jaunpuri$_1$, Kharra$_1$, Lucknow$_2$, Lucknow$_3$, Lucknow$_4$, Lucknow$_5$, Lucknow sweet$_1$, muskmelon$_1$, muskmelon$_2$, muskmelon$_3$, muskmelon$_4$, muskmelon$_5$, Roys$_1$, solid rock$_1$, dharidar$_1$, Jaunpuri$_2$, Faizabadi$_2$, Kharra$_2$, honey sugar rock$_2$, plain sweet$_1$, Faizabadi$_3$, mixed$_1$, model$_1$, muskmelon$_6$; delicious 51, Spartan rock, Edisto 47, Campo, Hales Best No. 36, Jacumba, PMR6, PMR 45 (U.S.A.) and local collections of C. melo viz. local$_1$ - local$_{30}$; on hot season$_1$, hirvi$_1$, Jaunpuri$_1$, kakri$_1$, Lucknow$_1$, kakri$_2$, Lucknow$_2$, melon kakri$_1$, hot season$_2$, kakri$_3$, Lucknow$_3$, melon kankur$_1$, phoont$_1$, white long Lucknow$_1$ of C. melo var. utilissimus; on large$_1$, long$_1$, small$_1$ of C. melo var. momordica; on Bareilly kalan$_1$, black seeded$_1$, Faizabadi$_1$, Faizabadi$_2$, sugar sweet$_1$, watermelon$_1$, hard skin$_1$, watermelon$_2$, white seeded$_1$, Farrukhabadi$_2$, Indian green$_1$, Jaunpuri$_2$, mixed$_1$, midget$_1$, quatar gola$_1$, white seeded$_1$, red seeded$_2$, watermelon$_3$, tarmuj$_1$, soft skin$_1$, white seeded$_1$ of C. vulgaris; on doodhi long summer$_1$, lauki Singapuri$_1$, bottle gourd$_1$, long white$_1$,

lauki long$_1$, long thin variety$_1$, lauki long$_2$, lauki round$_1$ of L. leucantha on black seeded$_1$, jhinga turai$_1$, jhinga baropata$_1$, jhinga bhunya$_1$ of L. acutangula, on ghia turai$_1$, ghia turai$_2$, small green$_1$, long green$_1$ of L. cylindrica. All the isolates were equally capable of producing perithecia. There were little difference with respect to the time required for the production of perithecia and it ranged between 20-25 days after inoculation. The number of perithecia per unit area was more on L. leucantha and C. sativus than on C. moschata, C. melo, C. melo var. utilissimus, C. melo var. momordica, C. vulgaris and L. cylindrica (Figs. 8, 9).

The detailed study of perithecia revealed that on L. leucantha, C. sativus, C.moschata and C. vulgaris possessed asci each containing 8 ascospores (Fig. 12), however, perithecia produced on C. melo var. utilissimus, C. melo var. momordica and L. cylindrica typical asci were present without ascospores and on C. melo lacked both asciand ascospores (Table 39(b); Figs. 10, 11, 12).

ON DETACHED LEAVES AND LEAF DISCS -

It is clear from the Table 39(b) that perithecia were produced on ribbed long green, doodhi long summer, doodhi and doodhi long vars. of L. leucantha on detached leaves or leaf-discs. However, the time required was less (11-15 days) than required (20-25 days) on potted plants. On all the varieties normal perithecia were produced.

TABLE 39(b)

Formation of perithecia of S. fuliginea on four varieties of L. leucantha on detached leaves or leaf-discs in humidity chamber.

Lagenaria leucantha	Isolates										Peri-thecia	Asci	Asco-spores
	*Ll_1		Ll_2		Cm_1		Cm_2		Lc_1				
	* D.l.	L.d.	D.l.	L.d.	D.l.	L.d.	D.l.	L.d.	D.l.	L.d.			
var. Ribbed long green$_1$	11	13	13	12	11	12	13	13	11	12	P	P	P
var. Doodhi long summer$_1$	12	12	13	12	12	13	13	12	12	13	P	P	P
var. Doodhi$_1$	13	11	13	14	12	13	14	12	13	14	P	P	P
var. Doodhi long$_1$	14	13	15	14	13	14	15	13	14	15	P	P	P

*Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* D.l. = Detached leaf
L.d. = Leaf disc

P = Present

Figures indicated the time required for the production of perithecia.

Fig. 8. Cotyledones of L. leucantha showing perithecia of S. fuliginea.

Fig. 9. Enlarged portion of stem with perithecia.

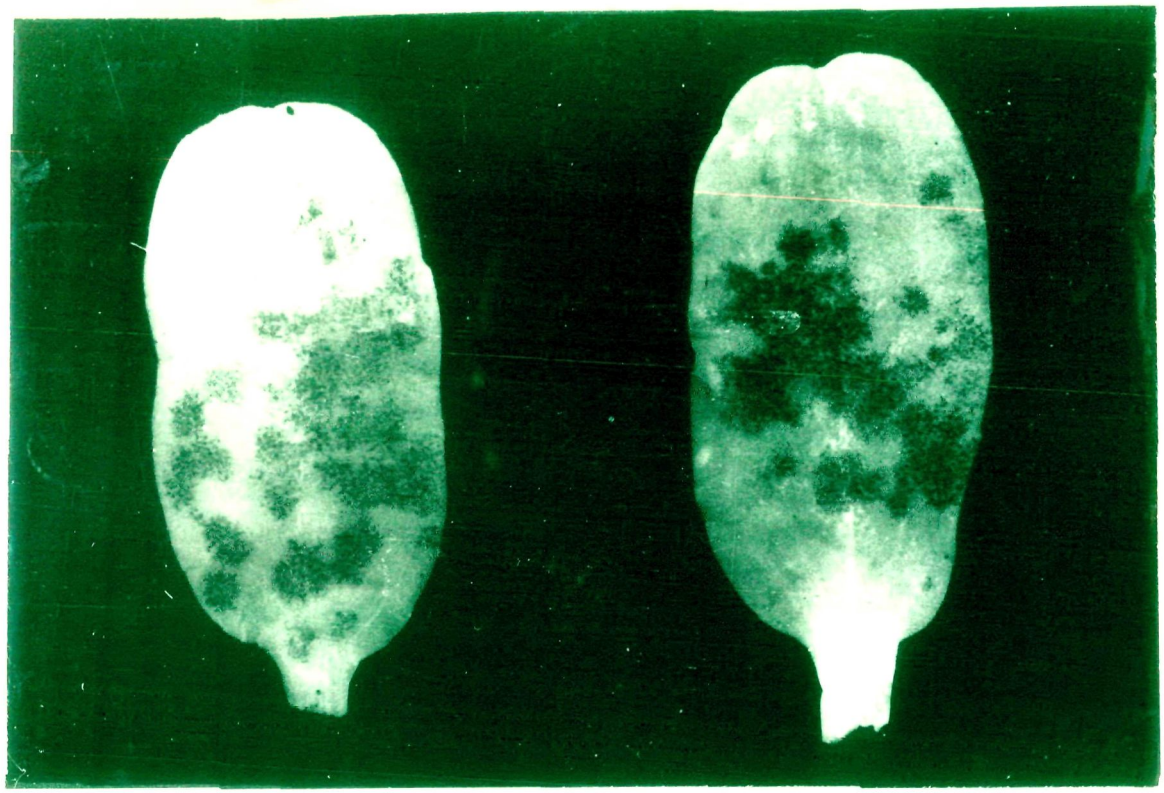

FIG. 8

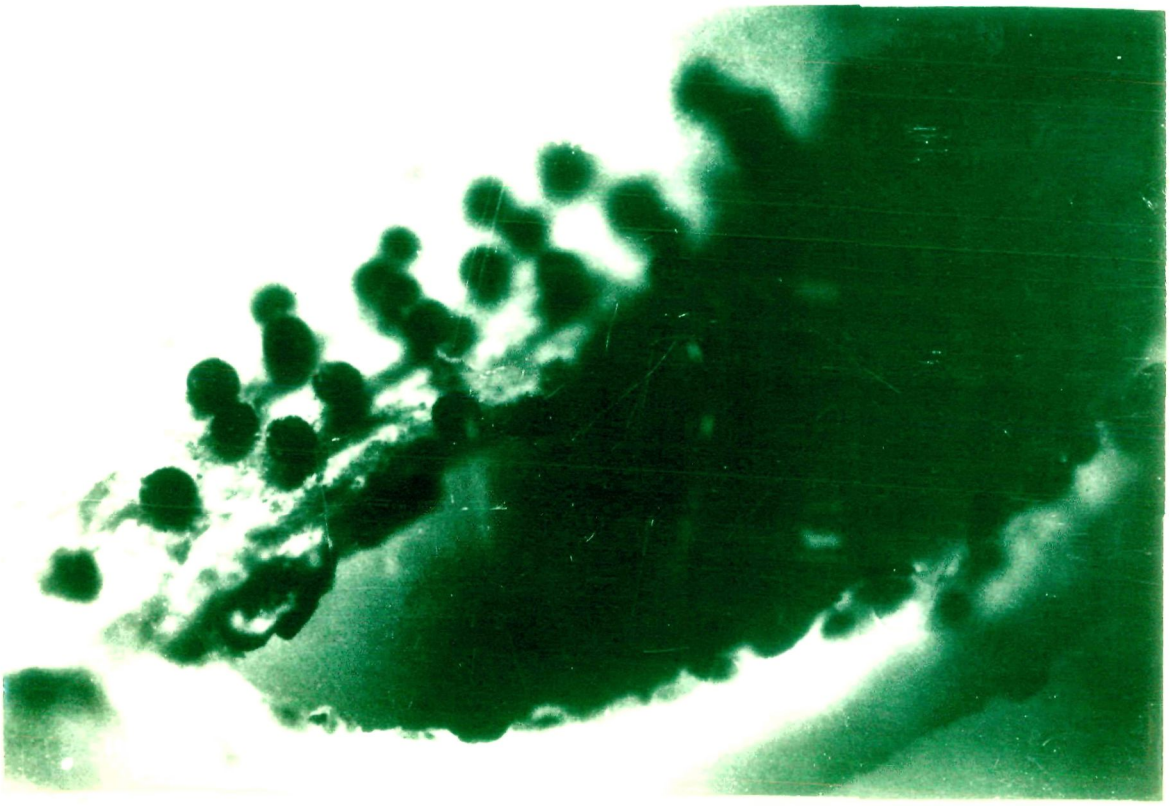

FIG. 9

Fig. 10(A) A close-up shot of *L. leucantha* leaf showing perithecia.

(B) A cluster of perithecia from *L. leucantha*.

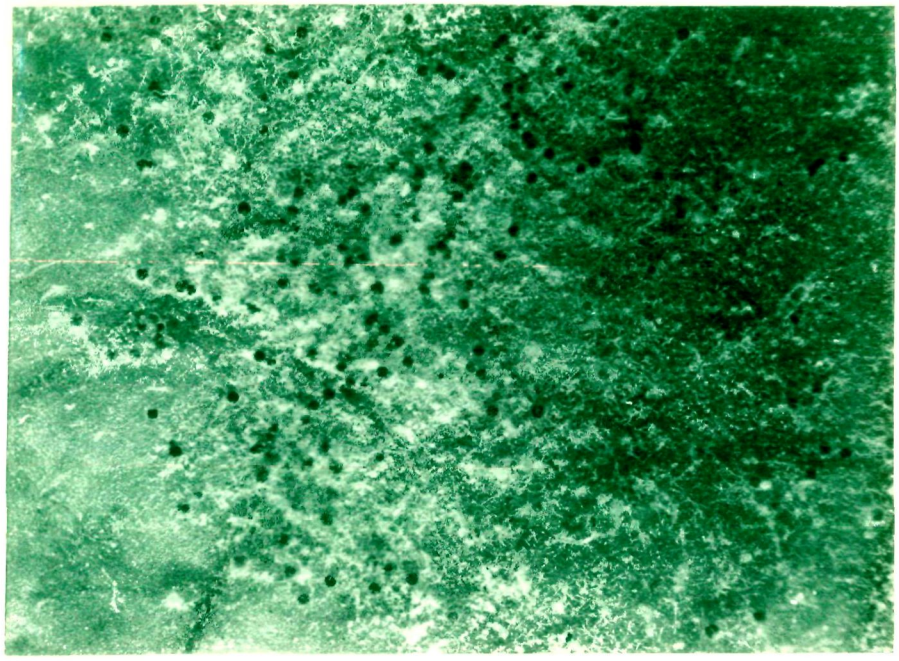

FIG. 10 A

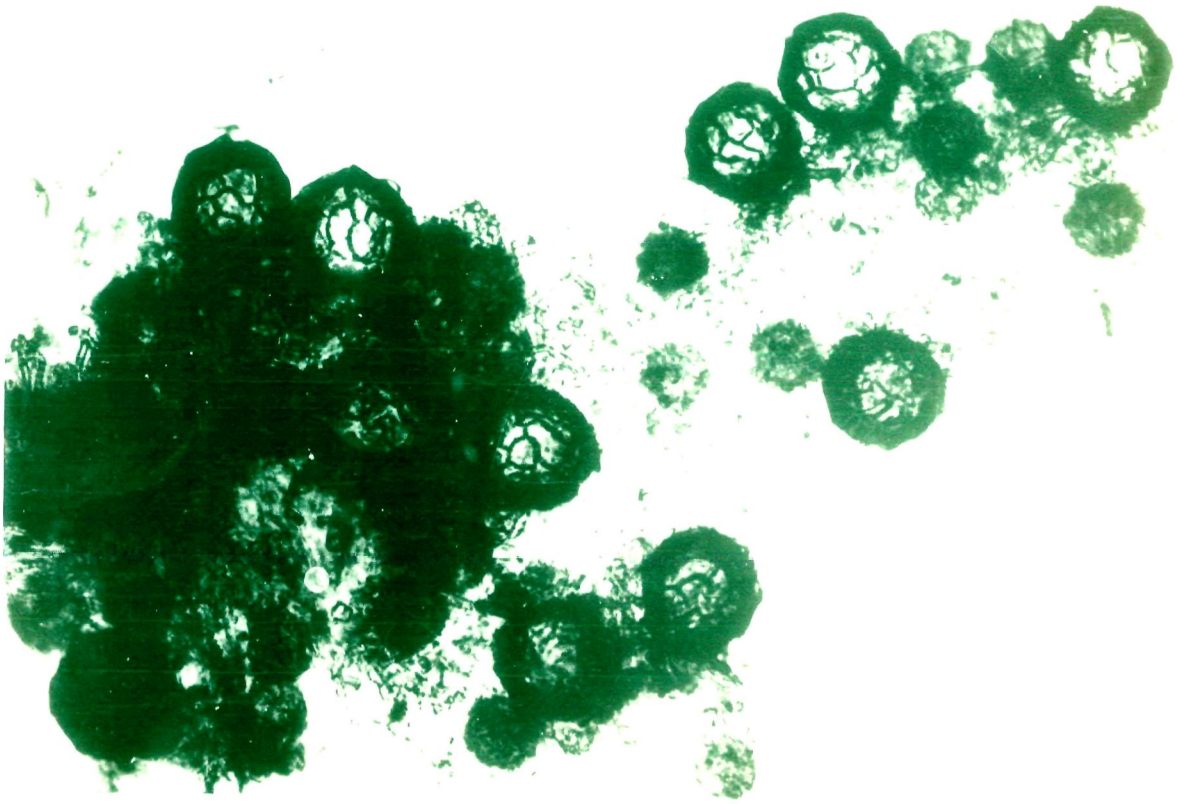

FIG. 10 B

Fig. 11. Ruptured perithecia of *E. fuliginea* with single ascus in each.

Fig. 12. Ascus with 8 ascospores.

FIG. 11

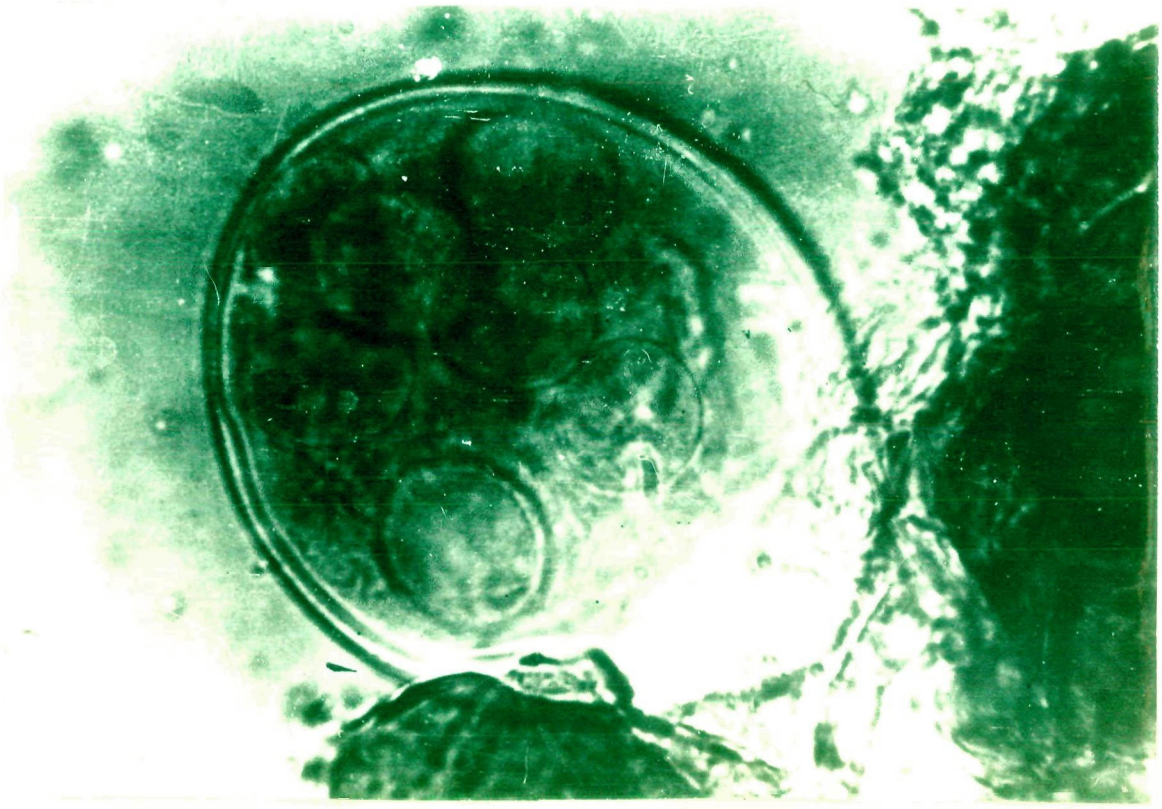

FIG. 12

Effect of NPK -

It is evident from the Table 40 that mildew developed on *L. leucantha* varieties ribbed long green, round and *C. vulgaris* variety sugar sweet irrespective of their nutritive status, however, the infection rating differed on plants receiving different treatments. The disease was severe on plants lacking either of the three elements.

The infection rating in each case was 4. The infection rating on the other hand, on plants receiving normal or double the normal dose of nutrients was 2 and 1 respectively.

Perithecia were produced only on plants grown either lacking nitrogen or plants receiving twice the normal dose of potassium.

Temperature and relative humidity -

It is clear from the Tables 41, 42, 43, 44, 45, 46 and Figs. 13-19, that when resistant and susceptible varieties of *C. melo* var. *utilissimus*, *C. sativus* and *C. vulgaris* were inoculated and later grown in growth chamber at 15°C, 20°C, 26°C, and 30°C at 70% relative humidity, the host response remained the same as in glasshouse tests. Similarly when they were grown at 50%, 70% and 90% relative humidities at 20°C, the infection rating did not materially change. Varieties which were resistant remained resistant and those which were

TABLE 40

The appearance of powdery mildew and production of perithecia on two varieties of L. leucantha and one of C. vulgaris as influenced by different levels of NPK.

Levels of NPK	Time in days for the appearance of						*Disease rating after 36 days		
	Disease			Perithecia					
	L. leucantha		C. vulgaris	L. leucantha		C. vulgaris	L. leucantha		C. vulgaris
	var. ribbed long green$_1$	var. round$_1$	var. sugar sweet$_1$	var. ribbed long green$_1$	var. round$_1$	var. sugar sweet$_1$	var. ribbed long green$_1$	var. round$_1$	var. sugar sweet$_1$
NPK	5	6	7	-	-	-	2	2	2
-N	4	4	4	20	14	-	4	4	4
½N	4	4	5	29	18	-	3	3	3
2N	5	5	5	-	24	-	1	1	2
-P	4	4	5	-	14	-	4	4	4
½P	4	5	5	-	21	-	3	3	3
2P	4	5	6	-	24	-	1	1	1
-K	4	5	5	-	16	-	4	4	4
½K	4	4	5	-	19	-	3	3	3
2K	6	5	5	34	28	-	1	1	1

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

TABLE 41

Host reaction of certain resistant varieties of C. melo var. utilissimus at four different temperatures and 70% relative humidity against five isolates of S. fuliginea.

Varieties	*Reaction against isolates																			
	*Ll_1				*Ll_2				Cm_1				Cm_2				Lc_1			
	Temperature in degree centigrade																			
	15	20	26	30	15	20	26	30	15	20	26	30	15	20	26	30	15	20	26	30
C. melo var. utilissimus																				
Hot season$_2$	0	0	1	2	0	0	1	2	0	0	1	2	0	0	1	2	0	0	1	2
Kakri$_3$	1	1	1	2	1	1	1	2	1	1	1	2	1	1	1	2	1	1	1	2
Lucknow$_3$	1	1	1	2	1	1	1	2	1	1	1	2	1	1	1	2	1	1	1	2
Melon kankur$_1$	1	1	1	2	1	1	1	2	1	1	1	2	1	1	1	2	1	1	1	2
Phoont$_1$	0	0	1	2	0	0	1	2	0	0	1	2	0	0	1	2	0	0	1	2
White long Lucknow$_1$	0	0	1	2	0	0	1	2	0	0	1	2	0	0	1	2	0	0	1	2
Lucknow geteer$_1$	2	2	3	3	2	2	3	3	2	2	3	3	2	2	3	3	2	2	3	3

*Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

TABLE 42

Host reaction of certain resistant varieties of C. melo and C. sativus at four different temperatures at 70% relative humidity.

Varieties	*Reaction against isolates																			
	*Ll_1				Ll_2				Cm_1				Cm_2				Lc_1			
	Temperature in degree centigrade																			
	15	20	26	30	15	20	26	30	15	20	26	30	15	20	26	30	15	20	26	30
Cucumis melo																				
Muskmelon$_6$	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Faizabadi$_1$	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Cucumis sativus																				
Short green$_1$	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
All season$_1$	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

*Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

TABLE 43

Host reaction of certain resistant varieties of Citrullus vulgaris at four different temperatures at 70% relative humidity against five isolates of S. fuliginea.

Varieties	*Reaction against isolates																			
	*Ll_1				Ll_2				Cm_1				Cm_2				Lc_1			
	Temperature in degree centigrade																			
	15	20	26	30	15	20	26	30	15	20	26	30	15	20	26	30	15	20	26	30
C. vulgaris																				
Farrukhabadi$_2$	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1
Indian green$_1$	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
Jaunpuri$_2$	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
Mixed$_1$	1	1	0	2	1	1	0	2	1	1	0	2	1	1	0	2	1	1	0	2
Midget$_1$	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1
Qatar gola$_1$	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
Red seeded$_2$	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1
Watermelon$_3$	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tarmuj$_1$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
White seeded$_3$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jaunpuri$_1$	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

*Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

Table 44

Host reaction of certain resistant varieties of C. melo var. utilissimus at three different relative humidities at 20°C against five isolates of S. fuliginea.

Varieties	* Reaction against isolates														
	°Ll_1			Ll_2			Cm_1			Cm_2			Lc_1		
	Relative humidities in %														
	50	70	95	50	70	95	50	70	95	50	70	95	50	70	95
C. melo var. utilissimus															
Hot season$_2$	1	0	2	1	0	2	1	0	2	1	0	2	1	0	2
Kakri$_3$	1	1	2	1	1	2	1	1	2	1	1	2	1	1	2
Lucknow$_3$	1	1	2	1	1	2	1	1	2	1	1	2	1	1	2
Melon kankur$_1$	1	1	2	1	1	2	1	1	2	1	1	2	1	1	2
Phoont$_1$	1	0	2	1	0	2	1	0	2	1	0	2	1	0	2
White long Lucknow$_1$	0	0	2	0	0	2	0	0	2	0	0	2	0	0	2
Lucknow geteer$_1$	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3

°Ll_1 = Melothria maderaspatana culture 1.
Ll_2 = Lagenaria leucantha culture 2.
Cm_1 = Cucurbita moschata culture 1.
Cm_2 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

TABLE 45

Host reaction of certain resistant varieties of *C. melo* and *C. sativus* at three different relative humidities at 20°C

Varieties	*Reaction against isolates														
	°Ll_1			Ll_2			Cm_1			Cm_2			Lc_1		
	Relative humidities in %														
	50	70	95	50	70	95	50	70	95	50	70	95	50	70	95
Cucumis melo															
Muskmelon$_6$	3	2	3	3	2	3	3	2	3	3	2	3	3	2	3
Faizabadi$_1$	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Cucumis sativus															
Short green$_1$	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2
All season$_1$	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

°Ll_1 = *Melothria maderaspatana* culture 1.
Ll_2 = *Lagenaria leucantha* culture 2.
Cm_1 = *Cucurbita moschata* culture 1.
Cm_2 = *Cucurbita moschata* culture 2.
Lc_1 = *Luffa cylindrica* culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

TABLE 46

Host reaction of certain resistant varieties of Citrullus vulgaris at three different relative humidities at 20°C against five isolates of S. fuliginea.

Varieties	* Reaction against isolates														
	*Ll_1			Ll_2			Cm_1			Cm_2			Lc_1		
	Relative humidities in %														
	50	70	95	50	70	95	50	70	95	50	70	95	50	70	95
C. vulgaris															
Farrukhabadi$_2$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indian green$_1$	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2
Jaunpuri$_2$	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2
Mixed$_1$	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2
Midget$_1$	2	0	2	2	0	2	2	0	2	2	0	2	2	0	2
Quatar gola$_1$	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2
Red seeded$_2$	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2
Watermelon$_3$	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2
Tarmuj$_1$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
White seeded$_3$	2	0	2	2	0	2	2	0	2	2	0	2	2	0	2
Jaunpuri$_1$	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

*Ll_1 = Melothria maderaspatana culture 1.
Ll_1 = Lagenaria leucantha culture 2.
Cm_2 = Cucurbita moschata culture 1.
Cm_1 = Cucurbita moschata culture 2.
Lc_1 = Luffa cylindrica culture 1.

* Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

Fig. 13. Effect of 15°, 20°, 26° and 30°C at 7% relative humidity on the development of disease on certain resistant varieties of C. melo var. utilissimus.

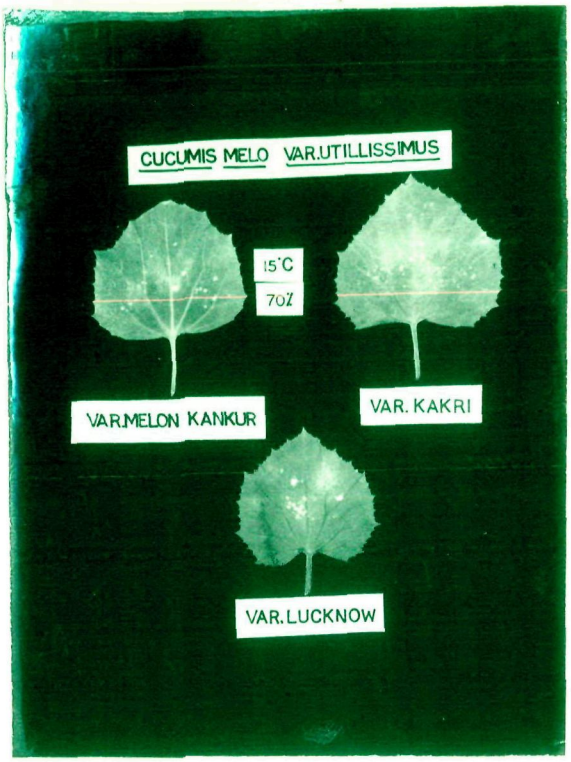

FIG. 13 A

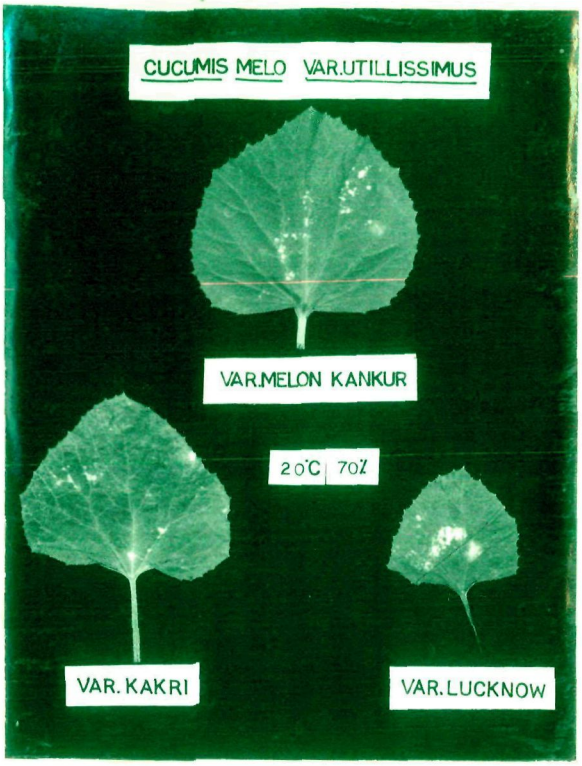

FIG. 13B

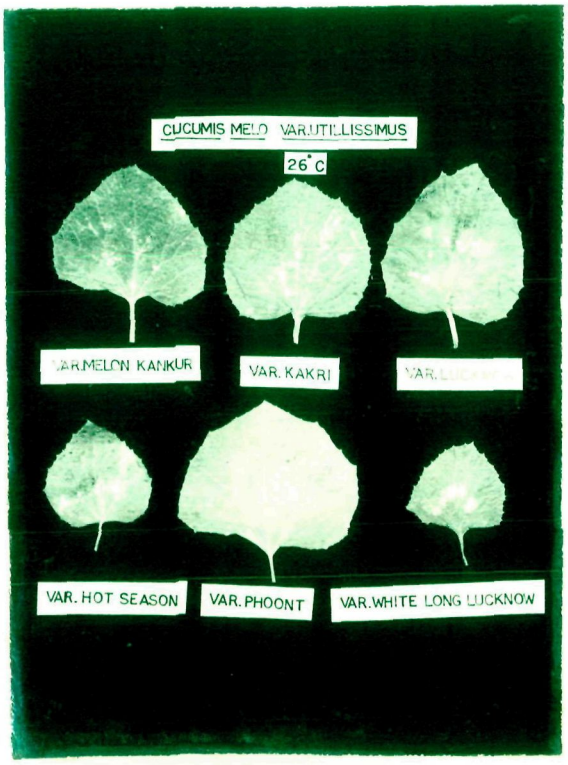

FIG. 13C

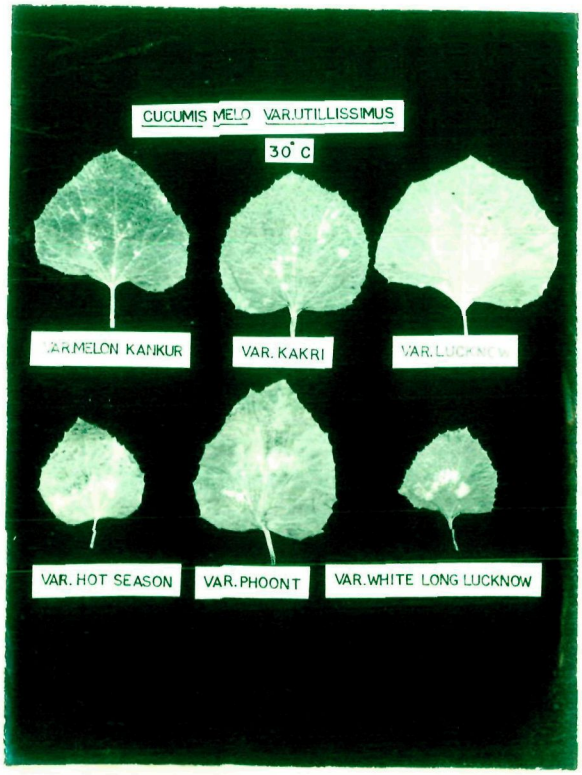

FIG. 13 D

Fig. 14. Effect of 15°, 20°, 26° and 30°C at 7% relative humidity on the development of disease on certain resistant varieties of *C. melo* and *C. sativus*.

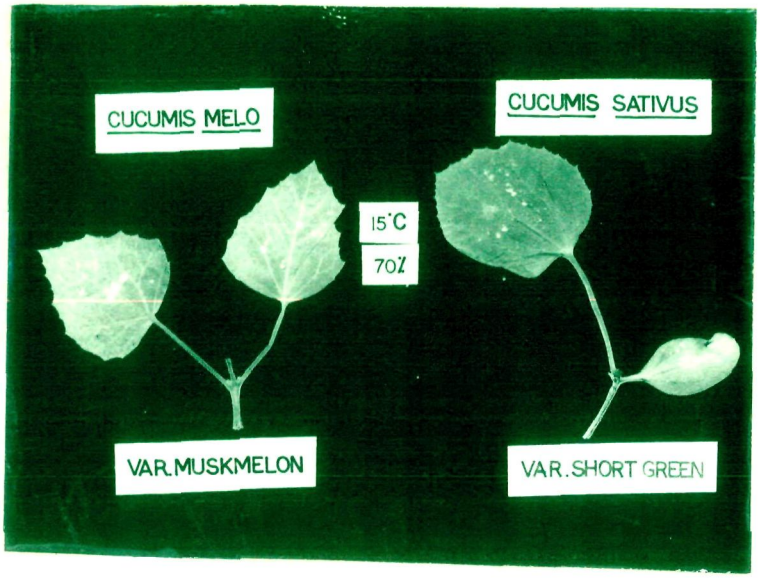

FIG. 14 A

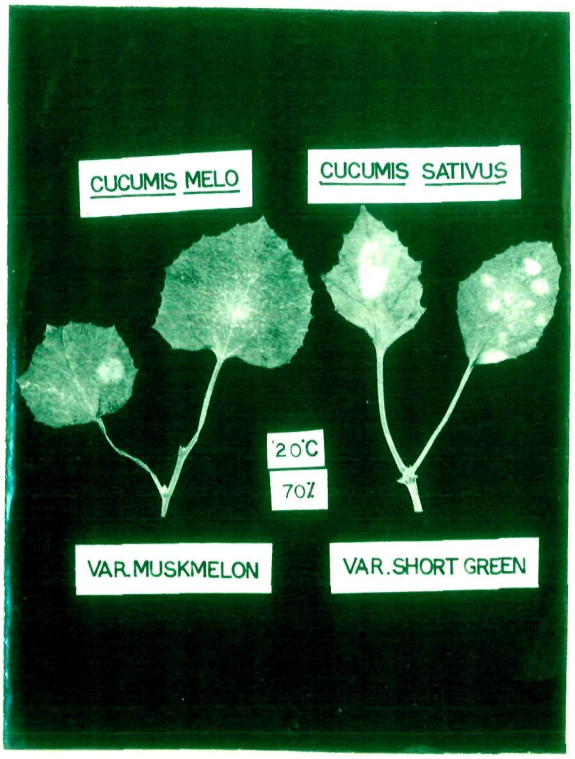

FIG. 14B

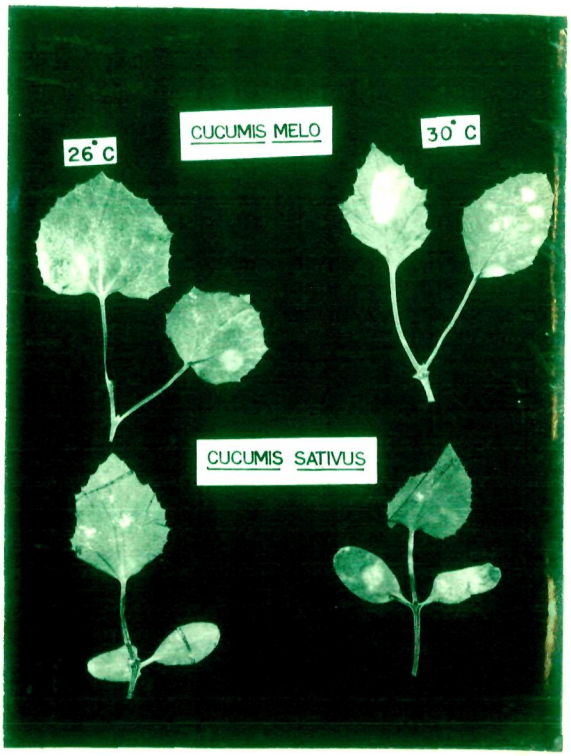

FIG. 14C

Fig. 15. (A,B.) Effect of 15° and 20°C at 7% relative humidity on the development of disease on certain resistant varieties of *C. vulgaris*.

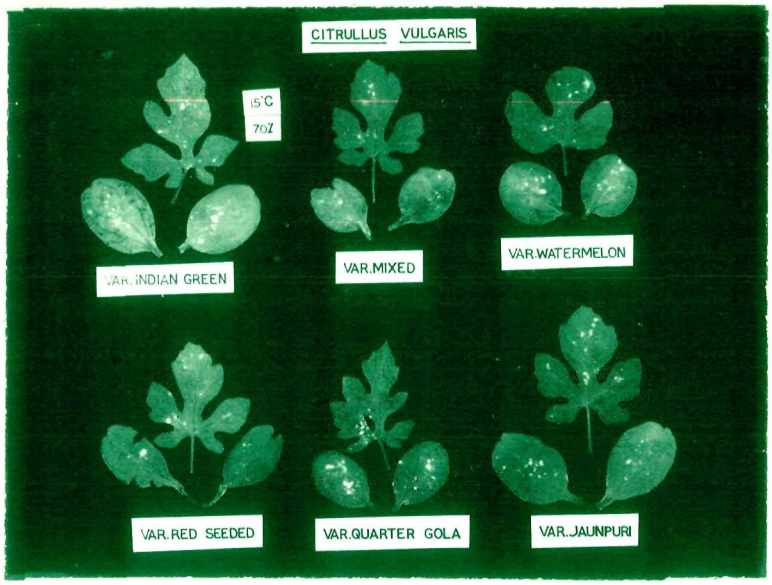

FIG. 15 A

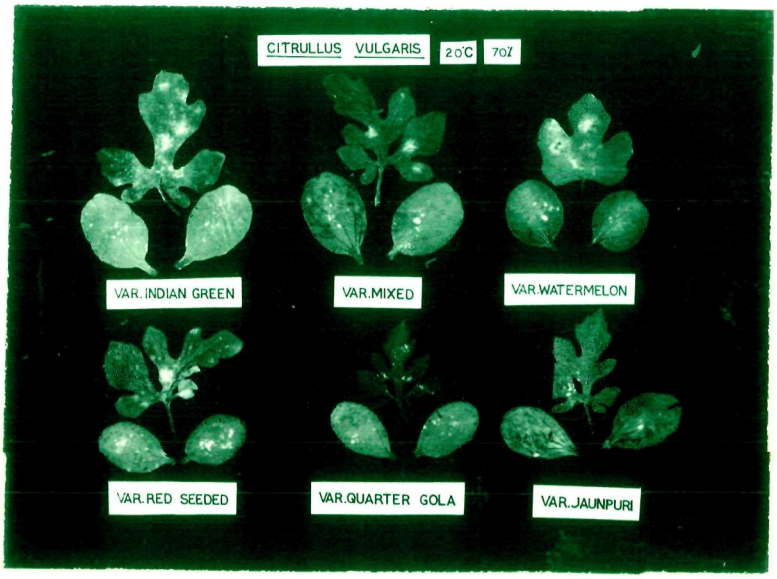

FIG. 15 B

Fig. 15 (C,D.) Effect of 26° and 30°C at 7% relative humidity on the development of disease on certain resistant varieties of *C. vulgaris*.

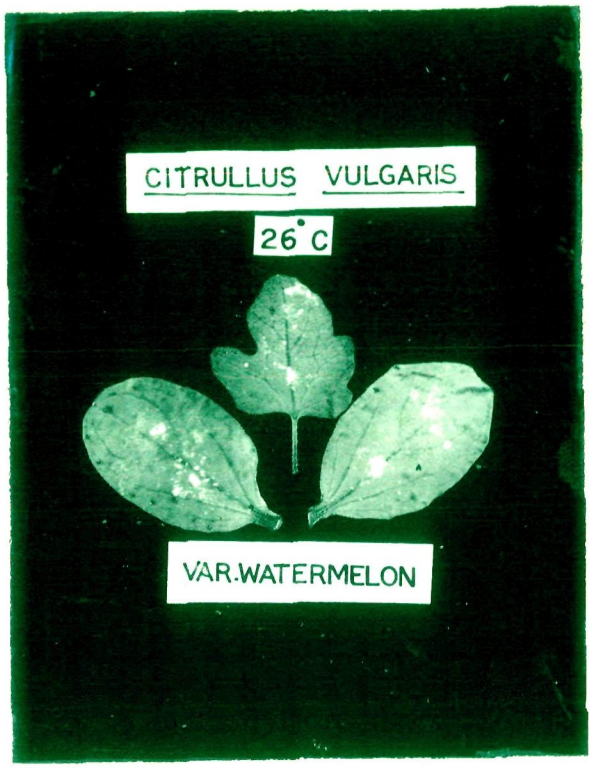

FIG. 15C

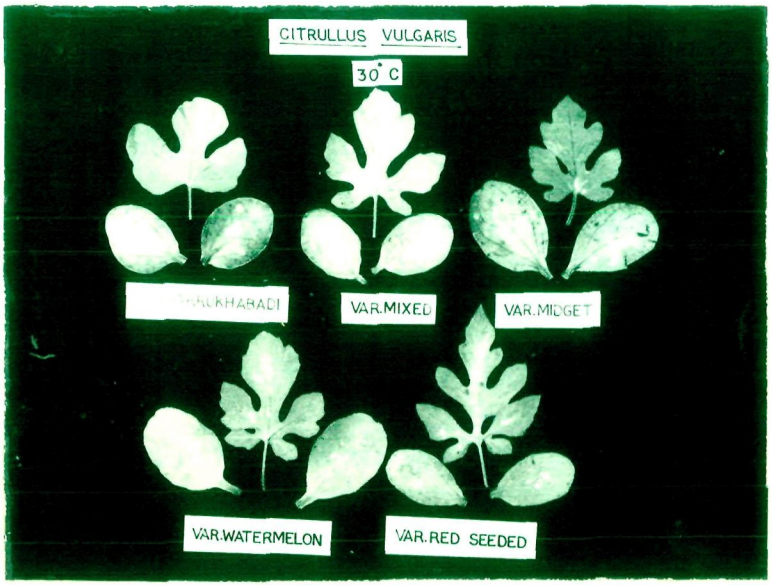

FIG. 15D

Fig. 16 (A,B,C). Effect of 50%, 70% and 95% relative humidities at 20°C on the development of disease on certain resistant varieties of C. melo var. utilissimus.

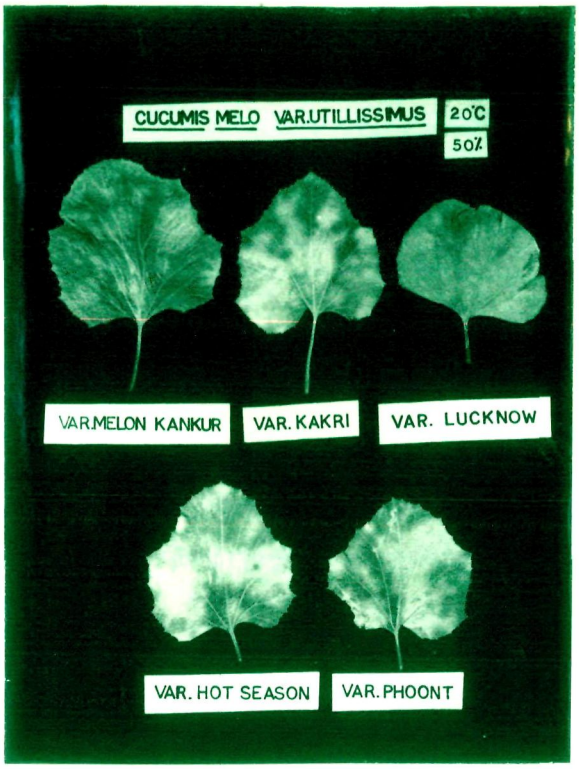

FIG. 16 A

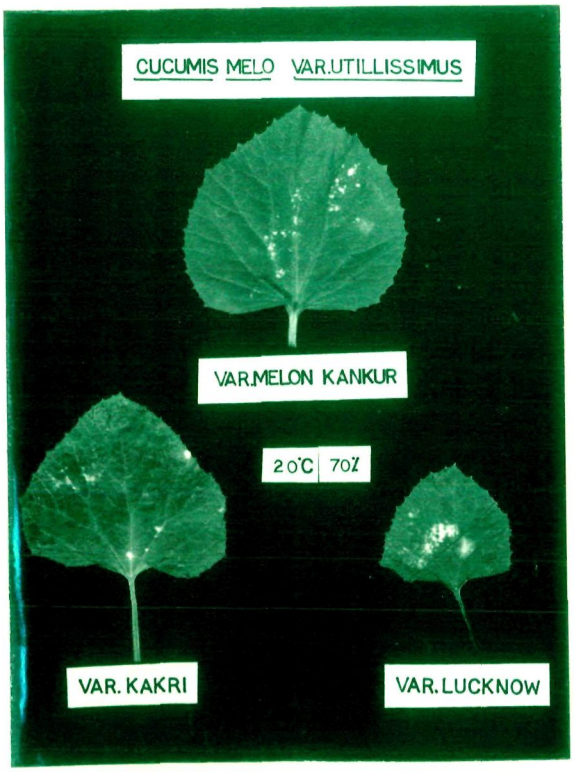

FIG. 16 B

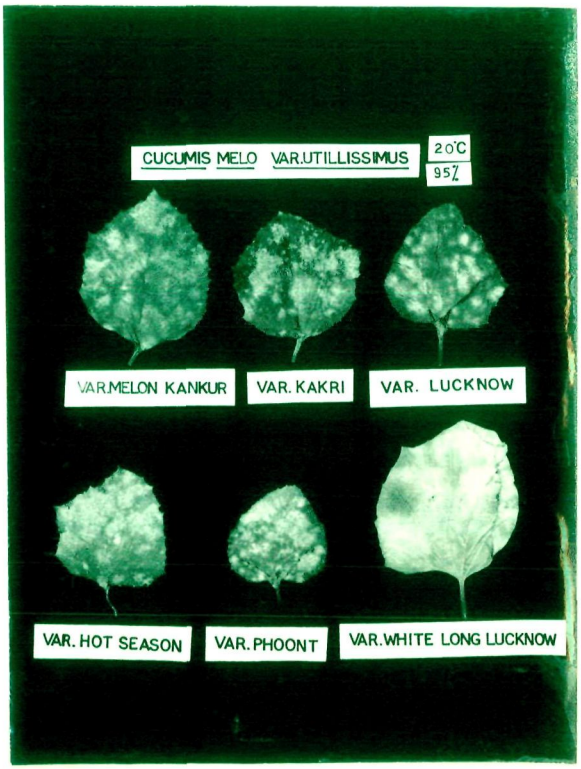

FIG. 16 C

Fig. 17. Effect of 50%, 70% and 95% relative humidities at 20°C on the development of disease on certain resistant varieties of *C. melo* and *C. sativus*.

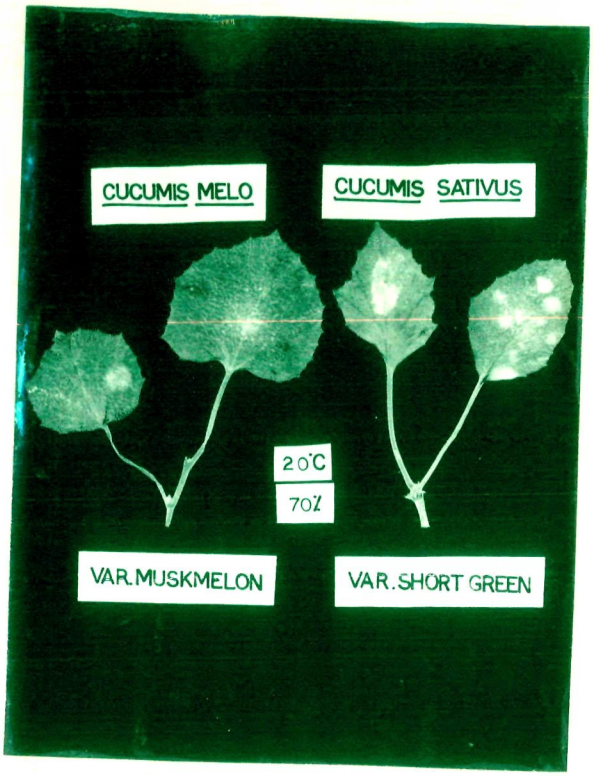

FIG. 17 A

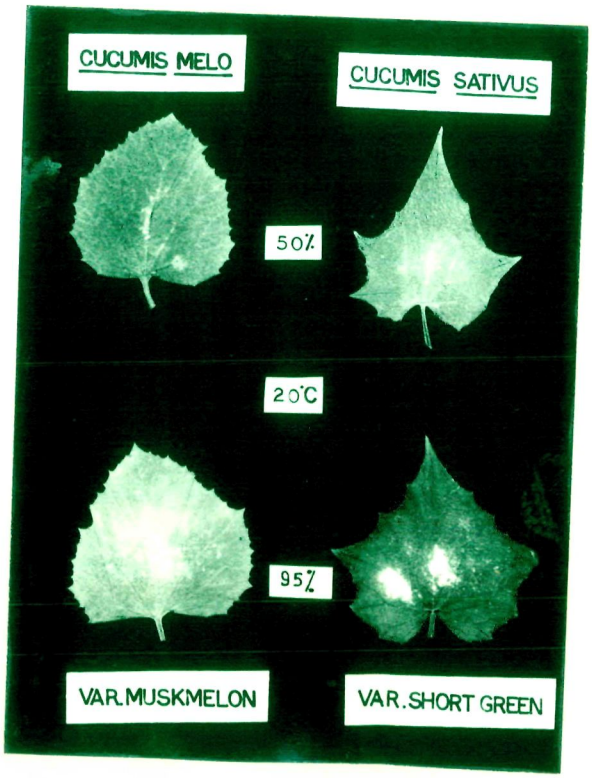

FIG. 17 B

Fig. 18. (A,B,C.) Effect of 50%, 70% and 95% relative humidities at 20°C on the development of disease on certain resistant varieties of *L. vulgaris*.

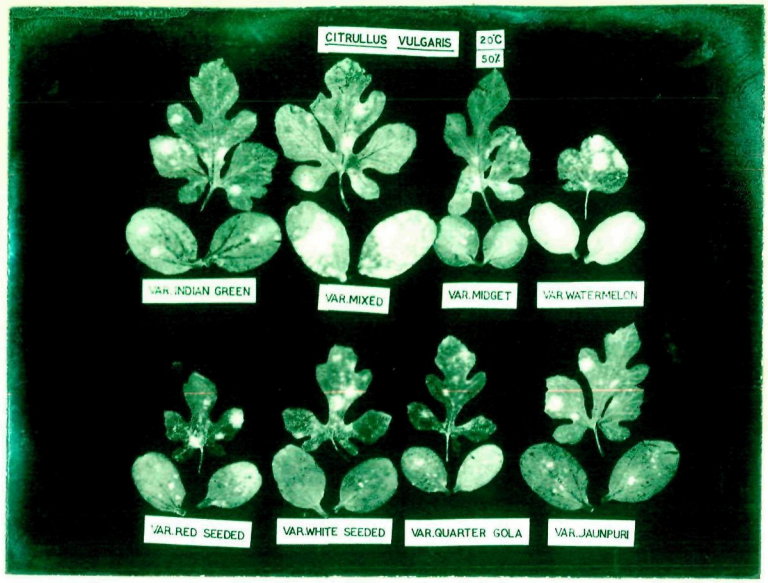

FIG. 18 A

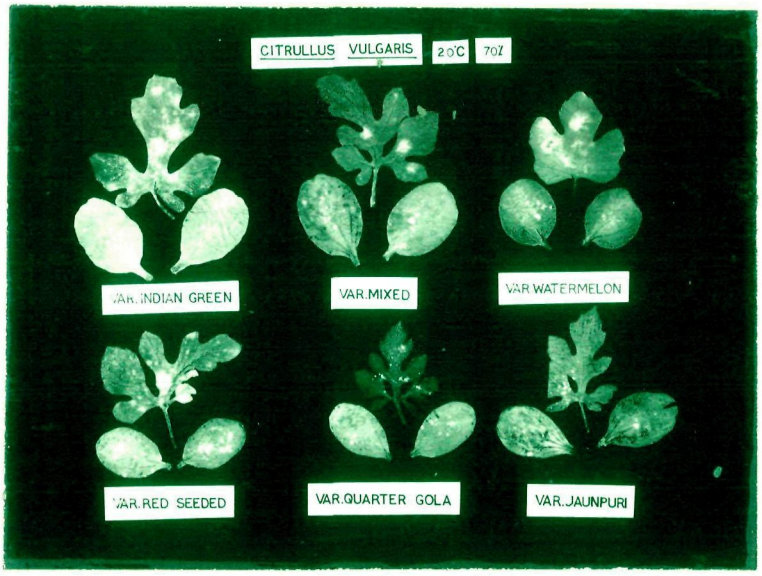

FIG. 18 B

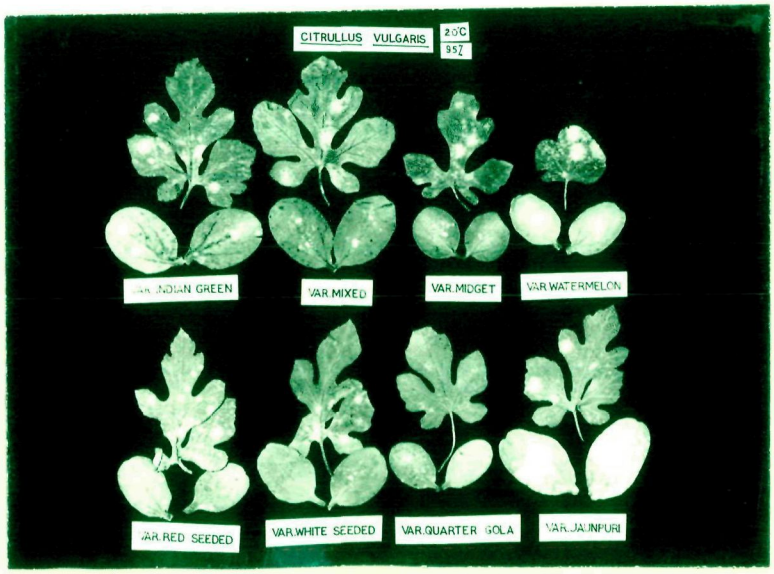

FIG. 18 C

susceptible remained susceptible. Neither the temperature nor relative humidity did not bring about any material change in hosts resistance.

Powdery mildew colonies were formed after 5 days at 60% and after 6 days at 80-90% relative humidities at 10°C, after 4 days at all the relative humidities at 15°C, after 3 days at all the relative humidities at 20°C and 22°C, after 5 days at 60% and after 4 days at 80% and 90% relative humidities at 25°C, after 6 days at 60% and after 5 days at 80% and 90% relative humidities at 30°C. However, disease failed to develop at 5°C and 35°C irrespective of the relative humidities maintained. The disease is more severe at all the temperatures at 80% and 90% relative humidities. However, perithecial development is restricted at 60% relative humidity (Tables 47 a, b, c).

Germination of conidia of S. fuliginea -

Conidia obtained from L. leucantha var. ribbed long green failed to germinate at 0°C-5°C. Germination at 5°, 10°, 32° and 35°C was traced. Moreover, a few conidia germinated which were immediately deformed. The percentage of germination after 72 hours at 10°, 17° and 20°C was 20.0, 46.3 and 40.0 respectively. The germination was initiated at the above temperatures 12 hours after incubation (Table 48).

Conidia failed to germinate in free water. The germination of conidia after 72 hours at 66, 78, 81, 90, 95 and 100% relative humidities at 20°C was 23.2, 22.3, 27.8, 35.8, 38.9 and 33.3% respectively. In the present case the germination was initiated 12 hours after incubation. The optimum

TABLE 47(a)

Time required for the development of disease when four varieties of Lagenaria leucantha inoculated with S. fuliginea growing in growth-chamber at different temperatures and three relative humidities.

Varieties	Temperature in °C																							
	5			10			15			20			22			25			30			35		
	Relative humidities in %																							
	60	80	90	60	80	90	60	80	90	60	80	90	60	80	90	60	80	90	60	80	90	60	80	90
Ribbed long green$_1$	(-)	(-)	(-)	(5)	(6)	(6)	(4)	(4)	(4)	(3)	(3)	(3)	(3)	(3)	(3)	(5)	(4)	(4)	(6)	(5)	(5)	(-)	(-)	(-)
Doodhi long summer$_1$	(-)	(-)	(-)	(5)	(6)	(6)	(4)	(4)	(4)	(3)	(3)	(3)	(3)	(3)	(3)	(5)	(4)	(4)	(6)	(5)	(5)	(-)	(-)	(-)
Doodhi$_1$	(-)	(-)	(-)	(5)	(6)	(6)	(4)	(4)	(4)	(3)	(3)	(3)	(3)	(3)	(3)	(5)	(4)	(4)	(6)	(5)	(5)	(-)	(-)	(-)
Doodhi long$_1$	(-)	(-)	(-)	(5)	(6)	(6)	(4)	(4)	(4)	(3)	(3)	(3)	(3)	(3)	(3)	(5)	(4)	(4)	(6)	(5)	(5)	(-)	(-)	(-)

Figures in parentheses denote the time in days.
(-) = Not appeared.

TABLE 47(b)

Effect of different temperatures and three relative humidities on the intensity of disease when four varieties of *L. leucantha* inoculated with *S. fuliginea* growing in growth-chamber.

Varieties	Temperature in °C																							
	5			10			15			20			22			25			30			35		
	Relative humidities in %																							
	60	80	90	60	80	90	60	80	90	60	80	90	60	80	90	60	80	90	60	80	90	60	80	90
Hibbed Long Green$_1$	0	0	0	4	3	3	3	4	4	3	4	4	3	4	4	3	4	4	2	3	3	0	0	0
Woodhi Long Summer$_1$	0	0	0	4	3	3	3	4	4	3	4	4	3	4	4	3	4	4	2	3	3	0	0	0
Woodhi$_1$	0	0	0	4	3	3	3	4	4	3	4	4	3	4	4	3	4	4	2	3	3	0	0	0
Woodhi Long$_1$	0	0	0	4	3	3	3	4	4	3	4	4	3	4	4	3	4	4	2	3	3	0	0	0

Highly susceptible = 4
Susceptible = 3
Moderately resistant = 2
Resistant = 1
Highly resistant = 0

TABLE 47(c)

Time required for the development of perithecia when four varieties of L. leucantha inoculated with S. fuliginea growing in growth-chamber at different temperatures and three relative humidities.

Varieties	Temperature in °C																							
	5			10			15			20			22			25			30			35		
	Relative humidities in %																							
	60	80	90	60	80	90	60	80	90	60	80	90	60	80	90	60	80	90	60	80	90	60	80	90
Ribbed long green$_1$	(-)	(-)	(-)	(15)	(-)	(-)	(20)	(-)	(-)	(19)	(-)	(-)	(20)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Doodhi long summer$_1$	(-)	(-)	(-)	(15)	(-)	(-)	(18)	(-)	(-)	(18)	(-)	(-)	(18)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Doodhi$_1$	(-)	(-)	(-)	(17)	(-)	(-)	(18)	(-)	(-)	(18)	(-)	(-)	(20)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Doodhi long$_1$	(-)	(-)	(-)	(17)	(-)	(-)	(21)	(-)	(-)	(18)	(-)	(-)	(19)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)

Figures in parentheses denote the time in days

(-) = Not appeared.

The effect of different temperatures at 100% relative humidity on the germination of conidia of *S. fuliginea* obtained from *L. leucantha* var. ribbed long green$_1$

Temperature in °C	Percentage germination of conidia/hours							
	4	8	12	24	36	48	60	72
0	-	-	-	-	-	-	-	-
-5	-	-	-	-	-	-	-	-
5	-	-	T	T	T	T	T	T
10	-	-	T	T	12.8	19.1	19.4	20.0
17	-	-	27.6	38.4	41.5	44.8	46.2	46.3
20	-	-	23.3	29.5	36.0	38.0	37.9	40.0
25	-	-	12.4	17.1	Td	Td	Td	Td
32	-	-	Td	Td	Td	Td	Td	Td
35	-	-	-	Td	Td	Td	Td	Td

- = No germination
T = Germination in traces
Td= Germination in traces but conidia were deformed.

germination occurred between 90 and 95 percent relative humidities (Table 49).

It is clear from the Table 50 that perithecia of E. fuliginea from L. leucantha and C. sativus when exposed to soil - environment later placed at a wide range of temperatures or a combination of temperatures failed to discharge ascospores as no infection took place on test plants. Similarly incubated on glass slides and placed in incubation chamber failed to germinate.

It is, therefore, concluded that even a prolonged exposure of perithecia (220 days) to soil-environment does not help in the maturation of ascospores.

TABLE 49

The effect of six different relative humidities at 20°C on the germination of conidia of E. fuliginea obtained from A. leucantha var. ribbed long green$_1$.

Humidities	Percentage germination of conidia/hours							
	4	8	12	24	36	48	60	72
66	-	-	12.7	13.5	14.3	16.10	18.8	23.2
78	-	-	12.21	13.5	17.2	20.02	21.6	22.3
81	-	-	13.5	15.31	19.7	23.2	24.3	27.8
90	-	-	19.6	23.2	27.8	33.3	35.5	35.81
95	-	-	21.2	27.8	33.4	35.6	35.8	38.9
100	-	-	21.6	24.3	33.8	35.81	35.5	38.3
Water	-	-	-	-	-	-	-	-

- = No germination

TABLE 50

Temperatures to which perithecia were exposed prior to transferring them either to humid-chamber or to the temperature cabinets.

No. of days/ hosts		Temperatures in °C							Combination of temperatures in °C					
		-5	5	10	17	22	25	30	5 & 17	5 & 22	5 & 25	10 & 17	10 & 22	10 & 25
10	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
20	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
30	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
40	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
50	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
60	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
70	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
80	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
90	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
100	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
110	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
120	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
140	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
160	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
180	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
200	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-
220	L. leu.	-	-	-	-	-	-	-	-	-	-	-	-	-
	C. sati.	-	-	-	-	-	-	-	-	-	-	-	-	-

L. leu. = L. leucantha - = No germination.
C. sati. = C. sativus

DISCUSSION AND CONCLUSIONS

Both S. fuliginea and E. cichoracearum have a wide host range which include cucurbits as well as non-cucurbits. In many cases the hosts are common (Huttenbach, 1952; Butler et al. 1960; Tafradzhiiski, 1962; Rudenko, 1968). Both are highly destructive and very rarely produce the perfect stage. Somehow, they differ with respect to their distribution. S. fuliginea is an important pathogen of cucurbits in Sudan, Japan, Australia and India(Tarr, 1952; Nour 1957; Clare, 1958; Kable and Ballantyna, 1963; Boerema and Vankesteren, 1964; Kapoor 1967; Jhooty, 1967; Sivakami et al. 1972; Bineeta Sen and Kapoor, 1974) whereas E. cichoracearum in the U.S.A., Egypt and U.S.S.R. (Jaczer, 1926; Fikry, 1936, Parris, 1949; Schmitt, 1954; Ivanoff, 1957).

It is only recently that S. fuliginea has been recognised as an important pathogen of cucurbits in India. Consequently very little work has been carried out. Hence studies have been carried out to establish the identity, host-range, host-specialization, factors responsible for the spread, recurrence of the disease and the role of perithecia in its spread.

In the absence of perfect stage, the two powdery mildews infecting cucurbits are differentiated on the basis of color of the mycelium and the conidial characters. S. fuliginea is characterised by greyish-white mycelium, forked

germtube and the presence of well-developed fibrosin bodies in conidia. Using the above characters for differentiation between the two powdery mildews it has been observed that S. fuliginea infects L. leucantha, C. moschata, M. maderaspatana and L. cylindrica in nature. When a variety of cultivated cucurbits have been inoculated with the cultures of above four hosts it has been noticed that the above cultures bring about moderate to severe infection on B. hispida, C. vulgaris, C. vulgaris, var. fistulosus. C. melo, C. melo var. utilissimus, C. melo var. momordica, C. sativus, C. moschata, C. pepo, C. maxima, of Sheela seeds, L. leucantha, L. acutangula, L. cylindrica, M. charantia and T. anguina; on M. maderaspatana, B. laciniosa, C. anguria, C. melo var. agrestis, C. ficifolia and L. graveolans amongst wild cucurbits. They however, fail to cause infection on C. maxima of Central Europe, T. dioica and a few varieties of C. vulgaris, C. melo var. utilissimus, one each of C. melo and C. sativus; on C. lanatus, C. cordifolia, L. echinata and T. cucumerina the cultivated and wild cucurbits respectively (Tables 2 and 3). Therefore, these studies confirm the findings of Butler et al. 1960; Kapoor, 1967, Jhooty, 1967, Blumer, 1967; Sohi and Nayar, 1969; Khan and Khan, 1970; Khan et al. 1971 and 1972; Sivakami et al. 1972; Bineeta Sen and Kapoor, 1974. Moreover, S. fuliginea has been found to infect B. hispida, C. vulgaris,

C. vulgaris var. fistulosus, C.melo, C. melo var. momordica, C. melo var. utilissimus, C. sativus, L. acutangula, L. cylindrica, M. charantia and T. anguina amongst the cultivated cucurbits and M. maderaspatana, B. laciniosa, C. anguria, C. melo var. agrestis, C. ficifolia and L. gravcolens amongst the wild cucurbits which has hitherto not been reported as the hosts of this fungus and thus are the new records (Tables 2 and 3).

The identity has further been confirmed when perithecia of S. fuliginea have been produced on Cucurbita maxima in nature; on C. vulgaris, C. melo, C. melo var. momordica, C. melo var. utilissimus, C. sativus, C. moschata and L. cylindrica in glasshouse by all the cucurbit isolates of S. fuliginea and on L. leucantha both in nature and in glasshouse. Thus it is safe to conclude that under Indian conditions S. fuliginea is much more prevelant than E. cichoraceanum. Further these studies also prove that S. fuliginea is not only confined to limited number of cucurbits in a particular locality but is wide spread throughout north India.

S. fuliginea as found on cucurbits is undoubtedly different from the one that infects non-cucurbitaceous hosts as repeated attempts have failed to give positive results (Tables 4, 8, 9 and 10). Thus these findings are at variance

with those reported by Neger, 1923; Miller, 1938; Marcelli, 1949; Huttenbach, 1951; Uozumi and Yoshii, 1952; Nour, 1959; Kowalski, 1966, Alcorn, 1967 and 1968; Munjal and Kapoor, 1973.

Resistance to S. fuliginea cucurbit isolates has been shown by C. maxima variety obtained from Central Europe, the only variety of T. dioica, six out of sixteen varieties of C. melo var. utilissimus, ten out of twenty five vars. of C. vulgaris, one out of twenty eight of C. melo, one out of twenty of C. sativus against S. fuliginea.

In majority of the tests the host response in glasshouse and field is the same. However, in case of C. vulgaris var. fistulosus, L. acutangula, L. cylindrica the varieties which have been susceptible in glasshouse have not been so in the field. C. vulgaris vars. white seeded and soft skin; C. melo var. momordica vars. small and phoont; C. melo var. utilissimus var. Lucknow geteer; C. sativus var. bhunya; C. moschata vars. red large and white bush and C. pepo of Sutton's on the other hand, have shown resistance in glasshouse but proved to be susceptible in field (Tables 12, 13, 17, 18, 19, 20 and 22).

Studies on different varieties of certain cucurbits as indicated in Tables 41-46 clearly demonstrate that different combinations of temperatures and relative humidities do not materially change the infection rating. Such varieties along with those which have been found to be resistant under glasshouse or in field can be used as resistant lines for future research.

Studies dealing with the host-range, varietal resistance and effect of temperature and relative humidity on the development of disease with the five cucurbit isolates clearly go to show that in north India there is only one single race of S. fuliginea infecting cucurbits. Production of perithecia also provides additional support about the similarity.

In glasshouse studies perithecia of S. fuliginea have developed on certain varieties of C. moschata, C. sativus, C. melo, C. melo var. momordica, C. melo var. utilissimus, C. vulgaris, L. leucantha and L. cylindrica and not on others (Table 39a, b). Further, all the isolates have equally been capable of producing perithecia. These studies also provide an additional proof for the existance of only one race of S. fuliginea in north India.

Deficiency of nitrogen, phosphorus or potassium has predisposed L. leucantha and C. vulgaris to the attack of the fungus. These findings are at variance with the observations of Stuch (1926) and Cole (1966). Further, the deficiency of these elements is also conducive for perithecial production (Table 40).

Data concerning the effect of temperature and relative humidity (Tables 47a, b, c) show that the temperatures below 10° or above 30°C donot favour the development of powdery mildew. Disease caused by S. fuliginea on cucurbits develops

best at 17-22°C, the range of temperature which is optimal for its conidial germination (Table 48). At all the relative humidities tried apparently at favourable temperatures, relative humidity is not of much importance in the development of the disease, however, the effect of relative humidity at temperatures below or above optimal for the development of the disease is quite significant.

Perithecial development on the other hand, is markedly influenced by relative humidity as even at optimal temperature perithecia develops best at 60% relative humidity and not at others. These findings receive an ample support with the data given on page 89, and also the findings of Blumer (1948). It is, therefore, concluded that cool temperatures and low relative humidity are required for the development of perithecia and these findings therefore explain as to why perithecial production is quite frequent at localities situated at higher altitudes where the temperature is cool and not on cucurbits grown in the indogengetic plains of India where cucurbits are a summer-crop.

Production of two flushes one in late January to March and the other from September to November, when the temperature is moderate; partial absence during the cooler parts of the year i.e. late December to middle of January and complete absence during hot season (late May to August)

leads one to conclude that under our conditions the problem is of over-summering rather than over-wintering. Similarly, the efforts to detect the presence of mycelium in vegetative buds also given the negative results.

Therefore, the question arises as to how S. fuliginea perennates under tropical conditions is still a dilemma. The only possible explanation of the recurrence of the disease in plains of north India that there is either a mutual exchange of conidia from the hills to the plains or vice versa or the discharge of ascospores from perithecia which have undergone longer period of maturation (Moseman et al. 1957). The work on these phases is in progress.

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* Original not seen.

APPENDIX - I

Table I

Composition of complete nutrient solution

Macronutrients		ppm.		
KNO_3	K	156	N	57
$Ca(NO_3)_2$ Anhyd.	Ca	160	N	113
$MgSO_4\ 7H_2O$	Mg	36	S	48
$NaH_2\ PO_4$	Na	31	P	41

Micronutrients		ppm.
Fe. Citrate $3H_2O$	Fe	5.6
$MnSO_4 \cdot 7H_2O$	Mn	0.55
$CuSO_4 \cdot 5H_2O$	Cu	0.054
$ZnSO_4 \cdot 7H_2O$	Zn	0.065
H_3BO_3	B	0.54
$(NH_4)_6\ Mo_7O_{24} \cdot 4H_2O$.	Mo	0.048

Table 2A

Compensation made for deficient element in the nutrient solution in order to maintain nutrient balance.

Deficiencies	Compensation made	Nutrient solution designated as
None (complete nutrient)	None	1N or 1P or 2K
Nitrogen	$Ca(No_3)_2$ and KNO_3 replaced by $CaCl_2$ and K_2SO_4.	-N
½ Nitrogen	$Ca(NO_3)_2$ and KNO_3 replaced proportionately by $CaCl_2$ and K_2SO_4.	½N
Phosphorus	NaH_2PO_4 replaced by $NaNO_3$	-P
½ Phosphorus	NaH_2PO_4 replaced by $NaNO_3$	½P
Potassium	KNO_3 replaced by $NaNO_3$	-K
½ Potassium	KNO_3 replaced by proportionately by $NaNO_3$	½K

Table 2-B

Additions made in order to maintain excess level of elements in the nutrient solution.

Excess level (Twice normal)	Additions made	Nutrient solution designated as
Nitrogen	Proportionate amounts of $Ca(NO_3)_2$, KNO_3 and $NaNO_3$.	2N
Phosphorus	Proportionate amount of NaH_2PO_4	2P
Potassium	Proportionate amount of KNO_3 and K_2SO_4.	2K

APPENDIX - II

Cultivars of different cucurbits	Name of the suppliers
Benincasa hispida	
vars. Khola petha$_1$	N. Cooper, Poona
" Petha gourd$_1$	Pocha Seeds, Poona
" Petha gourd$_2$	Prakash Seeds, Srinagar
" Petha gourd$_3$	Punjab Seeds, Aligarh
" Ash gourd$_1$	Bharat Beej, Saharanpur
Citrullus vulgaris	
vars. Red seeded$_1$	American Seed Store, Faizabad
" Red seeded$_2$	Salma Seeds, Farrukhabad
" Jaunpuri$_1$	Namdeo Seeds, Bombay
" Jaunpuri$_2$	A. Naik Seeds, Poona
" Allahabadi$_1$	Munnar Seeds, Varanasi
" Bareilly kalan$_1$	Namdeo Seeds, Bombay
" Black seeded$_1$	Salma Seeds, Farrukhabad
" Faizabadi$_1$	A. Naik Seeds, Poona
" Farrukhabadi$_1$	N. Cooper, Poona
" Farrukhabadi$_2$	Sheela Seeds, Kashmir.
" Sugar sweet$_1$	N. Cooper, Poona
" Watermelon$_1$	Salma Seeds, Farrukhabad
" Watermelon$_2$	Punjab Seeds, Aligarh
" Watermelon$_3$	Prakash Seeds, Srinagar

Cultivars of different cucurbits	Name of the suppliers
vars. Hard skin$_1$	Salma Seeds, Farrukhabad
" White seeded$_1$	Punjab Seeds, Aligarh.
" White seeded$_2$	Bharat Beej, Saharanpur
" White seeded$_3$	Salma Seeds, Farrukhabad
" Indian green$_1$	Namdeo Seeds, Bombay
" Mixed$_1$	N. Cooper, Poona
" Midget$_1$	N. Cooper, Poona
" Quatar gola$_1$	Bharat Beej, Saharanpur
" Tarmuj$_1$	Sutton Seeds, Calcutta
" Soft skin$_1$	N. Cooper, Poona
C. vulgaris var. *fistulosus*	
vars. Dilpasand tinda$_1$	Sutton Seeds, Calcutta
" Dilpasand tinda$_2$	Pocha Seeds, Poona
" Lucknow special$_1$	N. Cooper, Poona
" Tinda Delhi$_1$	Munnar Seeds, Varanasi
" Gourd tinda$_1$	Sutton Seeds, Calcutta
Cucumis melo	
vars. Local$_1$ to Local$_{30}$	Aligarh
C. melo (Indigenous)	
vars. Delicious$_1$	Namdeo Seeds, Bombay
" Faizabadi$_1$	Nasik Seeds, Nasik
" Faizabadi$_2$	American Seed Store, Faizabad
" Faizabadi$_3$	N. Cooper, Poona

Cultivars of different cucurbits	Name of the suppliers
vars. Honey sugar rock$_1$	Nasik Seeds, Nasik
" Honey sugar rock$_2$	N. Cooper, Poona
" Jaunpuri$_1$	Jaunpur Seeds, Jaunpur
" Jaunpuri$_2$	Bharat Beej, Saharanpur
" Kharra$_1$	Nasik Seeds, Nasik
" Kharra$_2$	American Seed Store, Faizabad
" Lucknow$_1$	Nasik Seeds, Nasik
" Lucknow$_2$	Sutton Seeds, Calcutta
" Lucknow$_3$	Kumaon Nursery, Ramnagar
" Lucknow$_4$	American Seed Store, Faizabad
" Lucknow$_5$	Sheela Seeds, Kashmir
" Lucknow sweet$_1$	Pocha Seeds, Poona
" Muskmelon$_1$	American Seed Store, Faizabad
" Muskmelon$_2$	Punjab Seeds, Aligarh
" Muskmelon$_3$	Globe Nursery, Calcutta
" Muskmelon$_4$	Kisan Seeds, Meerut
" Muskmelon$_5$	Nasik Seeds, Nasik
" Muskmelon$_6$	Sutton Seeds, Calcutta
" Roys$_1$	Globe Nursery, Calcutta
" Solid rock$_1$	N. Cooper, Poona
" Dharidar$_1$	Bharat Beej, Saharanpur
" Plain sweet$_1$	Bharat Beej, Saharanpur
" Mixed$_1$	N. Cooper, Poona
" Model$_1$	N. Cooper, Poona

Cultivars of different cucurbits	Name of the suppliers
(Foreign vars of *C. melo*)	
vars. Delicious$_{51}$	U.S.A.
" Spartan rock	U.S.A.
" Edisto$_{47}$	U.S.A.
" Campo	U.S.A.
" Hales Best No. 36	U.S.A.
" Jacumba	U.S.A.
" PMR$_{6}$	U.S.A.
" PMR$_{45}$	U.S.A.
C. melo var. *momordica*	
vars. Large$_{1}$	Ghazipur
" Long$_{1}$	Ghazipur
" Small$_{1}$	Ghazipur
" Phoont$_{1}$	American Seed Store, Faizabad
C. melo var. *utilissimus*	
vars. Hot season$_{1}$	Pocha Seeds, Poona
" Hot season$_{2}$	Radhey Seeds, Bareilly
" Hirvi$_{1}$	Nasik Seeds, Nasik
" Jaunpuri$_{1}$	Jaunpur Seeds, Jaunpur
" Kakri$_{1}$	Kisan Seeds, Meerut
" Kakri$_{2}$	Salma Seeds, Farrukhabad
" Kakri$_{3}$	Punjab Seeds, Aligarh

Cultivars of different cucurbits	Name of the suppliers
vars. Lucknow$_1$	Globe Nursery, Calcutta
" Lucknow$_2$	Radhey Seeds, Bareilly
" Lucknow$_3$	Munnar Seeds, Varanasi
" Lucknow geteer$_1$	Radhey Seeds, Bareilly
" White long Faizabadi	American Seed Store, Faizabad
" Melon kakri$_1$	Sutton Seeds, Calcutta
" Melon kankur$_1$	Sutton Seeds, Calcutta
" Phoont$_1$	American Seed Store, Faizabad
" White long Lucknow$_1$	American Seed Store, Faizabad
C. sativus	
vars. All season$_1$	N. Cooper, Poona
" Early$_1$	Prakash Seeds, Srinagar
" Hot season$_1$	N. Cooper, Poona
" Improved long green$_1$	N. Cooper, Poona
" Indian$_1$	Sutton Seeds, Calcutta
" Kheera$_1$	Bulandshahr
" Kheera$_2$	Durbhanga
" Kheera$_3$	Globe Nursery, Calcutta
" Kheera$_4$	Prakash Seeds, Srinagar
" Long$_1$	Jagadhri
" Long$_2$	Nasik Seeds, Nasik
" Long green$_1$	Pocha Seeds, Poona
" Long summer$_1$	American Seed Store, Faizabad

Cultivars of different cucurbits	Name of the suppliers
vars. Lucknowi$_1$	N. Cooper, Poona
" Rainy season$_1$	N. Cooper, Poona
" Poona kheera$_1$	Pocha Seeds, Poona
" Lucknow$_1$	Pocha Seeds, Poona
" Bhunya$_1$	Globe Nursery, Calcutta
" Kashmiri long$_1$	Globe Nursery, Calcutta
" Short green$_1$	Sutton Seeds, Calcutta
Cucurbita moschata	
vars. Early white bush$_1$	N. Cooper, Poona
" English marrow$_1$	N. Cooper, Poona
" Vegetable marrow$_1$	N. Cooper, Poona
" Bright red$_1$	Globe Nursery, Calcutta
" Red large$_1$	Globe Nursery, Calcutta
" White bush$_1$	Globe Nursery, Calcutta
" *C. pepo*$_1$	Sheela Seeds, Kashmir
" *C. pepo*$_2$	Sutton Seeds, Calcutta
" *C. maxima*$_1$	Central Europe
" *C. maxima*$_2$	Sutton Seeds, Calcutta
Lagenaria leucantha	
vars. Doodhi long$_1$	N. Cooper, Poona
" Doodhi long summer$_1$	N. Cooper, Poona
" Doodhi round$_1$	N. Cooper, Poona
" Bottle gourd$_1$	Pocha Seeds, Poona

Cultivars of different cucurbits	Name of the suppliers
vars. Long white$_1$	Pocha Seeds, Poona
" Lauki long$_1$	Salma Seeds, Farrukhabad
" Ribbed long green$_1$	Salma Seeds, Farrukhabad
" Long thin variety$_1$	Salma Seeds, Farrukhabad
" Lauki long$_2$	Prakash Seeds, Srinagar
" Lauki round$_1$	Sutton Seeds, Calcutta
Luffa acutangula	
vars. Black seeded$_1$	N. Cooper, Poona
" Jhinga turai$_1$	Sutton Seeds, Calcutta
" Jhinga baropata$_1$	Globe Nursery, Calcutta
" Jhinga bhunya$_1$	Globe Nursery, Calcutta
L. cylindrica	
vars. All season$_1$	N. Cooper, Poona
" Ghia turai$_1$	N. Cooper, Poona
" Ghia turai$_2$	Pocha Seeds, Poona
" Small green$_1$	Ghazipur
" Long green$_1$	Ghazipur
Momordica charantia	
vars. All season$_1$	N. Cooper, Poona
" Faizabadi$_1$	Munnar Seeds, Varanasi
" Long green$_1$	Prakash Seeds, Srinagar
" Karela$_1$	Sutton Seeds, Calcutta
" Karela$_2$	Bulandshahr

Cultivars of different cucurbits	Name of the suppliers
vars. Rainy season$_1$	N. Cooper, Poona
" Summer crop$_1$	Pocha Seeds, Poona
Trichosanthes anguina	
vars. Season$_1$	N. Cooper, Poona
" Extra long$_1$	Pocha Seeds, Poona
" Extra long special$_1$	Namdeo Seeds, Bombay
" Chichinga gourd$_1$	Sutton Seeds, Calcutta
" Globe phone$_1$	Globe Nursery, Calcutta
" Black$_1$	Globe Nursery, Calcutta
" Long green$_1$	Indian Seeds, Faizabad
" White$_1$	Indian Seeds, Faizabad
" White$_2$	Globe Nursery, Calcutta
" Snake gourd$_1$	Naik Seeds, Poona
" Snake gourd$_2$	Kumaon Nursery, Ramnagar
T. dioica	Patna University, Patna
Wild cucurbits	
Melothria maderaspatana	University Fort, Aligarh
Bryonopsis laciniosa	F.R.I., Dehra Dun
Cucumis anguria	Botanical Garden, Hungary
C. melo var. *agrestis*	University Fort, Aligarh
Cucurbita ficifolia	Tunisia
Luffa echinata	Patna University, Patna
L. graveolens	Patna University, Patna

Cultivars of different cucurbits	Name of the suppliers
Citrullus lanatus	Yugoslavia
Coccinia cordifolia	University Fort, Aligarh
Trichosanthes cucumerina	Patna University, Patna
Non-cucurbits	
Abelmoschus esculentus	I.A.R.I., New Delhi
Bellis perennis	Ranikhet
Calendula sp.	University Area, Aligarh
Chenopodium ambrosoides	University Area, Aligarh
Chrysanthemum sp.	Punjab Seeds, Aligarh
Cosmos sp.	Punjab Seeds, Aligarh
Dahlia sp.	Punjab Seeds, Aligarh
Helianthus annuus	Punjab Seeds, Aligarh
Physalis sp.	Botany Department, Aligarh
Plantago ruselii	Dal Lake Area, Srinagar
Sonchus sp.	Botany Department, Aligarh
Nicotiana tabacum	Punjab Seeds, Aligarh
Xanthium strumarium	University Area, Aligarh
Zinnia elegans	University Area, Aligarh